477

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Contribution to the comparative histology of pulvini and the resulting photeolic movements.[1]

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WITH PLATE XXXIV.

Since the work that I have already completed upon the comparative histology of pulvini and the resulting photeolic movements is too extended to permit of presentation in these pages, the large mass of details in connection with each species will be passed over, and only an outline of the work carried out will be here attempted. The complete paper will be published elsewhere later.

Aim of study.

Inasmuch as the majority of investigators have busied themselves with seeking an explanation of the movement of leaves with motor organs without paying very great attention to their histology, the literature dealing with the structure of the pulvinus is comparatively scanty. The present work was undertaken as a contribution to the comparative histology of motor organs, hoping that a better knowledge of their structure might aid in understanding their physiology.

The work that I have already done seems to indicate that the presence of motor organs is much more general than was at first supposed. Not only the material collected, but observations in connection with the field work confirm this opinion. It remains for further study to reveal to what extent the supposition is correct.

In connection with the anatomy of the organs I have sought to give a general idea of the positions which the leaves assume at night. It was not considered necessary to measure the exact angles which the petioles form with the axes nor the angles of the leaflets with the rachis in the diurnal and

[1] Abstract of a thesis for the degree B. S. in Botany, University of Wisconsin, June, 1894.

nocturnal positions, since the angles vary with different individuals, and with the same individual at different times. All that was sought was the general extent and direction of the movements.

I pass over the account of earlier investigations which forms the historical introduction to my paper and set forth the

Present state of knowledge as to the physiology of the motor organs.

Pfeffer[2] found that the rise of the leaves of Phaseolus, when assuming the night position, was brought about by the increase of the turgidity of the cells of the lower half of the pulvinus and a diminution of the turgor of the cells in the upper half; the reverse occurs when assuming the day position. From this it is evident that changes of an opposite nature take place simultaneously in the cells of the two opposed halves of the pulvinus.

There are three ways in which the change of the hydrostatic pressure might occur: (1) by a change in the osmotically active substances of the cell sap; (2) by a change in the elasticity of the cell-walls; (3) by a change in the resistance of the protoplasm to the escape of cell sap. The first two are shown by Vines[3] to be out of the question, and the third remains as the explanation of the changes in turgidity. With illumination comes the restoration of the protoplasm to its original condition, and the absorption of water into the cell. The change in the protoplasm being entirely invisible, it may be inferred that there occurs a rearrangement of the molecular structure or possibly the breaking down of the protoplasmic molecule. In the latter case the restoration of the original condition would simply be the building up of the protoplasmic molecule. Briefly, the mechanism of the movement may be stated as variations in the degree of turgidity of the opposed halves of the motor organs, in accordance with changes in the molecular structure of the protoplasm. The molecular changes are brought about under the influence of the alternation of light and darkness.

In connection with this subject I must mention the work of Haberlandt[4] on the conduction of "stimuli" in Mimosa

[2] Pfeffer; Die periodischen Bewegungen der Blattorgane 166. 1875.
[3] Vines; Physiology of Plants 62–64. 1886.
[4] Haberlandt; Das reizleitende Gewebe-system der Sinnpflanze. 1890.

pudica. His investigations contradict those of Dutrochet[5] and others. He finds that the impulse normally travels inside the collenchyma ring but outside the xylem of the bundles, in other words, in the phloem. When a stem is cut, drops come from special cells in the phloem and not from the xylem as was formerly supposed. The phloem of Mimosa, like that of many of the leguminous plants, is characterized by rows of somewhat larger cells than the true sieve-cells, which from the nature of their contents are known as tannin cells. He concludes that the impulse is transmitted by these rows of glucoside cells, and that in a purely mechanical manner. This is against the theory of Vines[6] that the impulse travels by the continuity of the living protoplasm, for Haberlandt found that the impulse could be transmitted through parts that had been killed by steam.

A few words in regard to what Vines terms[7] the transmission of the "stimulus." In accordance with animal physiology the use of the term is incorrect. It is not the stimulus that is transmitted but the stimulus upsets the equilibrium and the resulting impulse is transmitted. Heat as heat is not transmitted, a mechanical force as such is not transmitted, but each gives rise to impulses that are transmitted. Why then in the case of plants like Mimosa is it not the impulse from the stimulation which sets off the cells of the succeeding motor organs and causes the leaflets to fold together? We should speak of the transmission of impulses and not stimuli and in one more way unify the two sciences.

In order that we may obtain a correct idea of the movements to be dealt with, a short outline of the movements of plant organs is here given. Passing by the movements of growing organs, or auxotonic movements, which do not specially concern us, there are the movements of mature organs, or allasotonic movements, which comprise the following:

1. Spontaneous movements, resulting from conditions which we are unable to interpret.

2. Induced movements, or those resulting from stimulation. According to the nature of the stimulus we distinguish those due

[5] Vines; Physiology of Plants 583. 1886.
[6] Vines; *op. cit.* 584-587.
[7] Vines; *op. cit.* 582.

a. To variation in the intensity of light. Called "sleep movements;" "nyctitropic movements;" "variation movements." (Pfeffer.)
b. To variations in temperature.
c. To mechanical stimuli.
d. To electrical stimuli.
e. To chemical stimuli.
f. To intensity and direction of light, or para- and diaheliotropism.

Suggestions on terminology.

The phrase "sleep of plants" is, of course, entirely fanciful. Even as far back as the time of Senebier it was known that this Linnean phrase was not scientifically correct, yet it has continued in quite frequent use even up to the present time. The movements have also been called nyctitropic movements, among which Darwin includes the nutation movements of growing leaves. Even if we confine this term to the movements of plants with motor organs, the term is still not a good one. Etymologically it means night-turning movements; now from the nature of the movements, it is evident that since the leaves assume a different position at the approach of day, it would be just as proper to use a term meaning day-turning movements. For this reason it seems to me that some other term would be better. Since we know the real cause of the movements, the gradual variation in the intensity of the light, would not a word expressing that be better? For this reason I propose the term photeolic movements, from the Greek φως meaning light, and αιολος, variable. This term would be only applicable to movements of leaves which have special motor organs, and not to those similar movements which are auxotonic.

One more point in regard to the terminology, for it seems to me to be of importance that we use terms that are scientifically correct. The special organ of motion is commonly called, "the motile organ," or the "pulvinus," which is the same as the "Gelenkpolstern" of the Germans. In his paper on "The mechanism of movement in Cucurbita, Vitis and Robinia," Penhallow[8] speaks of tendrils as motile organs. We can not deny him the right to use this term, for tendrils certainly are motile organs. Here then is a confusion of a com-

[8] Penhallow; Mechanism of movement in Cucurbita, Vitis and Robinia. 49. 1886.

mon term, using the same for two very different structures. Burdon-Sanderson[9] speaks of the organs as "motor organs." I do not know whether it was a mere accident on his part or a premeditated change, but as he states no reason for so doing, I judge that it was the former. It is, however, a happy suggestion and therefore instead of the term which is in such common use, motile organ, I propose to adopt the term motor organ for those structures whose curvatures set in motion other passive parts. In electro-mechanics it is the motor that drives the machinery. Now the motor organ, like the electric motor, causes other structures to move, the leaf being passive and taking whatever position is necessitated by the curvatures of the motor organ. This, then, seems to me to be an especially good term, and in adopting it we shall avoid confusion in the minds of those who do not command a view of the whole subject.

Method and material.

The material for the work on this subject was collected during the summer of 1893, in the months of June, July and August. At the same time that the collection of material was made the positions of the leaves were noted. A small case containing bottles of Flemming's fluid was carried into the field; the specimens of motor organs were snipped off with a pair of scissors, leaving only such additional parts of leaves, petioles and axes as were necessary for examination, and placed immediately in the fixing fluid. The plants were visited during the day, the position of the leaflets noted, and material collected. They were again visited about dark, and specimens of the organs in their nocturnal position were obtained; at the same time a record of the position of the leaflets was made. Some leaves were slow in assuming their nocturnal position, and in those cases it was necessary to visit them later in the evening. In thus taking the observations from field specimens, I avoided the danger of vitiated observations which are possible in studying a plant out of its natural habitat. On the other hand the observations required considerable time and trouble because some of the species were local, and it was necessary to go to a distance in order to obtain specimens from them.

The specimens of the motor organs, which were placed in Flemming's fluid as soon as removed, were allowed to remain

[9] Burdon-Sanderson; The Excitability of Plants. Nature. **26:** 353, 483. 1882.

for twelve to twenty-four hours, or until they were perfectly fixed. They were then removed, washed with water, and carried through the different grades of alcohol up to 70%, where they were allowed to rest. Sections were cut and stained with either borax-carmine or hæmatoxylin, washed, then passed through 95% and 100% alcohol, cleared in oil of origanum, and mounted in balsam. For the study it was necessary to have transverse sections of the motor organ, of the petiole above and below the motor organ, and of the rachis; also median longitudinal dorsiventral sections of the organs in their diurnal and in their nocturnal positions. Over one hundred and fifty slides were prepared for the work. The borax-carmine stain was used for the majority, and it was found necessary to leave the specimens in the stain for about twelve hours, on account of the slowness with which they took it up.

Species studied.

Twenty-five species representing four families and seventeen genera were studied. The following is the list:

I. LEGUMINOSÆ.

Baptisia leucophaea Nutt., *B. leucantha* Torr. & Gray, *Trifolium pratense* L., *T. hybridum* L., *T. repens* L., *T. procumbens* L., *Melilotus alba* Lam., *Medicago lupulina* L., *Amorpha canescens* Nutt., *Petalostemon violaceus* Michx., *P. candidus* Michx., *Desmodium acuminatum* DC., *D. canescens* DC., *D. Canadense* DC., *Lespedeza capitata* Michx., *Vicia sativa* L., *Lathyrus ochroleucus* Hook., *L. venosus* Muhl., *L. palustris* L., *Apios tuberosa* Moench, *Amphicarpæa monoica* Nutt., *Gleditschia triacanthos* L.

II. GERANIACEÆ.

Oxalis corniculata L., var. *stricta* Sav.

III. POLYGALACEÆ.

Polygala verticillata L.

IV. MALVACEÆ.

Abutilon Avicennæ Gærtn.

Definitions.

In the descriptions which follow I have called the motor organ located at the base of the petiole the *primary organ.* In the pinnate leaves the whole of the secondary petiole or

petiolule is transformed into a motor organ, this I term the *secondary organ*. (Contrast with Penhallow's paper.) In the case of bi-pinnate leaves, the petiolules of the secondary leaflets may be transformed into motor organs and these I term *tertiary organs*. The term *ventral* has been used to indicate the upper side of the organ, leaf-blade or petiole, that is, the side toward the axis in the bud, the *dorsal* being the lower side or that which is away from the axis in the bud. Following the example of Penhallow[10], I have used the term hypodermal tissue to mean the tissue between the stele and the epidermis which is derived from the periblem. Vines[11] calls this *extra-stelar* fundamental tissue. In the motor organ the pith is either pushed to one side and the cell-walls become thickened or it remains in the center of the stele; when the former is the case, the stele is generally somewhat kidney shaped in cross section, the remnant of pith occupying the depression. This depression I have termed the *hilum of the stele* in order to facilitate description. In the descriptions I have given the external appearance of the motor organs and the changes in position of leaves from normal diurnal positions to the nocturnal positions. I have then in each case given the anatomy of the organs, beginning with the primary and following this with the secondary and the tertiary organs when present.

From the twenty-five species described I select one, which though treated at greater length than the majority is best adapted for illustration.

Melilotus alba.

Melilotus alba shows well developed motor organs and consequently very marked movements. It has a primary motor organ which will be noticed as a slight thickening of the petiole just above the bract-like stipules, each of which contains a well developed schizostele. These schizosteles arise half way around the central stele of the axis and pass upwards and towards the base of the pulvinus, where just before uniting with the middle schizostele, they are almost at right angles to the axis. These three schizosteles of which the center one is the largest unite in the center as they pass through the motor organ proper. Besides being an enlarge-

[10] Penhallow; *loc. cit.* 76.
[11] Vines; Students' Text Book of Botany 146. 1894.

ment of the petiole the organ is noticeable on account of its darker green color. The secondary motor organ, as in Trifolium, constitutes the whole of the petiolule, but here there is a rachis intervening between the mesopodium and the pulvinus of the terminal leaflet. [This was referred to when speaking of Trifolium procumbens in the preceding genus.] Unlike those of Trifolium, the organs do not show any difference in size as they are continued on into the mid-rib, but shade off gradually so that their limit can only be determined externally by their difference in color. The rachis continues for about half an inch before the terminal leaflet is given off and the organ of this leaflet is a little smaller than the rachis, there being quite an abrupt change in size, as shown in plate XXXIV, figs. 1 and 2.

In the normal diurnal position the petiole forms a right angle with the internode above its insertion, and the three leaflets are spread out in a horizontal position. The leaf shows other very marked movements not photeolic, and one of these may be noted early in the morning when the sun is still in the east. The petiole curves so as to bring the plane of the laminæ at right angles to the incident rays of the sun. If the plants are visited in the late afternoon it will be found that the upper surfaces of the leaflets are similarly turned towards the setting sun. This is due to the so-called transverse heliotropism and is to be separated from the movements brought about by the variation in the intensity of light. If the plants are observed in the hottest part of the day they will be found to have assumed a position different from the one just described. The blades of the leaves are brought to occupy a position parallel to the incident rays of the sun, by turning upwards; this movement is connected with the protection of the chlorophyll from the intense rays of the sun, and is due to the so-called paraheliotropism. These movements are mentioned so that it may be understood that they are not similar to, and have not been confused with, the phottteolic movements.

In assuming the nocturnal position the primary petiole approaches the axis above its insertion, passing through an angle of 20–30°, thus coming to make an acute angle with the axis. The two lateral leaflets turn upwards so as to bring the upper faces together, but they never twist upon their axes. The terminal leaflet approaches the axis, sometimes

directly without any twisting, while at other times a slight twist is made. They thus assume nearly the same position as the leaflets of T. repens, only the position seems different on account of the upright growth of the axis.

Darwin[1,2] describes the "sleep movements" of a large number of species of the genus Melilotus, and as the type of their movements, he selects a case altogether different, in that the movement is the exact reverse of what I have found in Melilotus alba, although this is one of the species that he enumerates. Special pains was taken to make sure of this movement and plants were visited again and again with always the same result. It could hardly be that Darwin made a mistake and as he mentions a similar movement in one species at a different time, it is possible that the movement may sometimes differ in the same species. From this reversion of the movement to the Trifolium type, Darwin is inclined to speculate, and regards it as an indication of the close relation of the two genera. Since all photeolic movements are either up or down I can see no basis for such speculation.

Primary organ.—The pulvinus of the petiole as seen in the cross section is kidney shaped, fig. 4, the hilum being directed upwards or towards the ventral side of the petiole. The dorsiventral diameter is about 1.4^{mm}, the lateral diameter 1.75^{mm}, while the length is only about 1.4^{mm}. From these measurements it will be seen that the organ is quite short being only as long as its dorsiventral diameter. In the diurnal position the organ has a single transverse depression on each side, that on the ventral side being somewhat closed up, but not as deep as the one upon the dorsal side. In the nocturnal position there is a marked change in the outline; the transverse depression on the dorsal side becomes less marked as the petiole approaches the axis, while the motor organ, on its ventral side, is thrown into transverse folds for its entire length, (3 or 4 folds) the depth of the depressions depending upon the degree of movement that has taken place. As a general rule the depressions are deeper at the base of the organ and become more shallow towards the distal end.

There is a gradual change in the epidermis in passing from the leaf or petiole, so gradual indeed that it is impossible to tell exactly where the cells belong to the one or the other region. The epidermal cells of the pulvinus are of about

[1,2] Darwin; Movement of Plants. 346, *fig. 140.* 1880.

equal dimensions radially and tangentially, but are shorter in the longitudinal direction in accordance with the general type of motor organ cells. In consequence of the thickening of the walls the cell cavities are more or less spherical, fig. 3. The epidermal cells of the dorsal side are larger than those on the ventral side. The internal walls are much thicker in the longitudinal direction than the external walls, and very much thicker than the radial walls (fig. 3). The external wall also shows longitudinal ridges as in Trifolium pratense and other species.

The cells of the hypodermal tissue are different upon the upper and under sides of the organ. Those immediately beneath the epidermis are of about the same size as the epidermal cells, but towards the center the first few cells increase in size, then there is a decrease until the central stele is reached where they are even smaller than the epidermal cells. The cells of the dorsal side of the motor organ in the region of the hilum are smaller than those of the other side and their walls are more uniformally thickened while the cell cavities are generally four sided in cross section. The remainder of the hypodermal cells are of the collenchyma type, fig 3. They are very much thickened at the corners and the middle lamellæ are very marked. The side walls, although they look thin when compared with the thickened corners, are yet very much thicker than the walls of the adjacent parenchyma. Upon the ventral side of the organ in the region of the depression, which remains permanent, the cell walls are very thick and the cells irregular in shape. In some cases the opposite walls nearly touch each other, and when the nocturnal position is assumed the cells in the region of all the transverse depressions become very much distorted in shape. In the region of the central stele there are a few intercellular spaces, but towards the periphery they are entirely absent. The cells near the axis cylinder contain an abundance of chlorophyll, but those near the surface have a less abundant supply. Like all those previously described the cells have a peripheral layer of protoplasm, with the center occupied by a large vacuole.

Cross sections of the hypopodium were cut, and the origin of the bundles from the axis which was externally indicated, was confirmed. The purely mechanical advantage of this arrangement is at once clearly seen, and when it is noted that these three schizosteles come together at the base of the pul-

vinus and pass through that organ as a single cylinder, separating again as soon as beyond the limits of the motor organ, one is again impressed by the mechanical advantage which is gained by this course. As shown in the cross section the central meristele is kidney shaped in agreement with the form of the organ and is entirely surrounded by a cylinder of bast fibers. (The outline is shown in fig. 4.) The cells with the thickened walls at the hilum, which are considered to represent the remnant of the pith, have very much thicker walls than the remainder of the bast fiber layer which is made up of the bast fibers belonging to the phloem of the bundles. As seen in the longitudinal section the cells at the hilum are found to be short fusiform cells, while the latter are much longer and contain straight cross partitions which are much thinner than the longitudinal walls. The phloem forms a continuous ring around the xylem except at the hilum. The xylem vessels, spiral, pitted and reticulated, radiate from the hilum and between them are well marked pith rays the cells of which are filled with granular protoplasmic contents. From the short longitudinal dimensions of the cells of the motor organ proper, it might be thought that on account of the tensions set up, the cells of the vascular bundles would likewise be shorter than elsewhere. This supposition is confirmed by observation. The pitted and spiral vessels show cross walls much more frequently than in the general bundles of the plant.

Secondary organ.—The secondary pulvinus is nearly circular in cross section, 0.7^{mm} in diameter. The length is 1.4^{mm}, i. e., twice as great as its diameter. As seen in the cross section the epidermal cells are of the same size as the hypodermal collenchyma cells but their longitudinal dimensions are less than the same of the collenchyma. The external epidermal wall is very thin and covered with a thin cuticle which shows longitudinal ridges as already described for the primary motor organ. The radial diameter of the cells is about twice their longitudinal dimension, but beyond the limits of the organ their three dimensions are about equal, or if any difference is to be detected the longitudinal is greater.

The whole of the hypodermal cells from the epidermis to the vascular cylinder show a marked regularity in size and form; they are arranged in regular longitudinal rows, but do not fit together in the manner of all those previously des-

cribed but have square end walls. They are of the same collenchyma type as shown in the organ of the petiole, but the thickening at the corners is not quite as marked. In Trifolium repens the walls of the pulvinus parenchyma cells are slightly thicker than the walls of the adjacent parenchyma. A few of the cells for that organ are shown in fig. 5; as compared with those, a few cells from the organ of Melilotus alba are shown in fig. 6. The difference in the thickness of the cell walls is to be noted. The cells are about equal in their tangential and radial dimensions but their length is slightly less. No intercellular spaces whatever could be detected, but the whole of the hypodermal cells are richly filled with chlorophyll bodies, while the protoplasm always occupies the periphery with a large vacuole in the center.

In the diurnal position the organ is slightly curved and shows very marked and regular transverse wrinkles for the entire length. When the organ assumes its night position it becomes more curved; the wrinkles on the ventral side become more marked while those on the other side are to a certain extent obliterated, figs. 7 and 8. These organs are contractions rather than enlargements of the petiolule. The same distortion of the cells in the region of the transverse depressions is to be noted as in the primary organ.

The schizosteles, as they emerge from the primary organ, traverse the petiole in the position shown in fig. 9 and give off lateral branches to the secondary motor organs in which they still occupy the center. The stele with its surrounding bast fibers is circular in cross section to agree with the form of the organ itself and it shows the same remnant of pith as in previous cases. By comparing the cross sections of the steles of the petiole and motor organs, it is found that the elements have been reduced in size; the bast fibers have thicker walls and are decidedly smaller, while the sieve cells have undergone such a modification in the thickness of their walls that it is almost impossible to tell which are bast fibers and which sieve cells, so closely do the two regions merge into each other. Otherwise the arrangement is very similar to that described for the primary organ, so no further description is needed. In the rachis the schizosteles occupy the same position as in the petiole and at the end come together to form the central stele of the terminal leaflet.

Conclusion.

From the study of the twenty-five species, I have found that there are, considering their diversity, many striking resemblances in the external and internal anatomy of the motor organs, of which I here give a short summary:

1. Organs may be found at the base of the petiole, and as such they are termed primary organs. In the species considered the primary organ may be altogether absent or represented by an imperfect development. As a general rule simple leaves do not possess pulvini; but one exception has been noted in the case of Abutilon Avicennæ, in which the organ is at the base of the leaf blade, or epipodium. This, however, I consider as a primary organ. The petiolules of each leaflet of pinnate and bi-pinnate leaves are transformed into motor organs, the secondary and tertiary organs. In the case of pinnate leaves, whenever any pulvini are present, it is always these which are found, no examples being discovered in which a primary organ was present without secondary organs.

2. The organs generally show a difference in color from the adjacent tissue. In the organs containing chlorophyll the color is darker green, which it must be concluded is due to the fact that the organ contains but few intercellular spaces. The pulvini which do not contain chlorophyll are generally yellowish. This color is due to the presence of yellow coloring matter, probably xanthophyll. In all the color may be modified by trichomes, and in Abutilon Avicennæ there is a red coloring matter in the epidermal cells.

3. As might be expected, different stages in the development of the pulvini are found in the species described. All gradations, from the very simplest indication to the perfectly developed organ, are to be found. These rudimentary pulvini are always at the base of the petiole and never secondary or tertiary organs The beginning development is to be detected by the enlargement of the base of the petiole, the modification of the hypodermal cells to agree with the motor organ type, and in the convergence of the schizosteles towards the center to form a single cylinder.

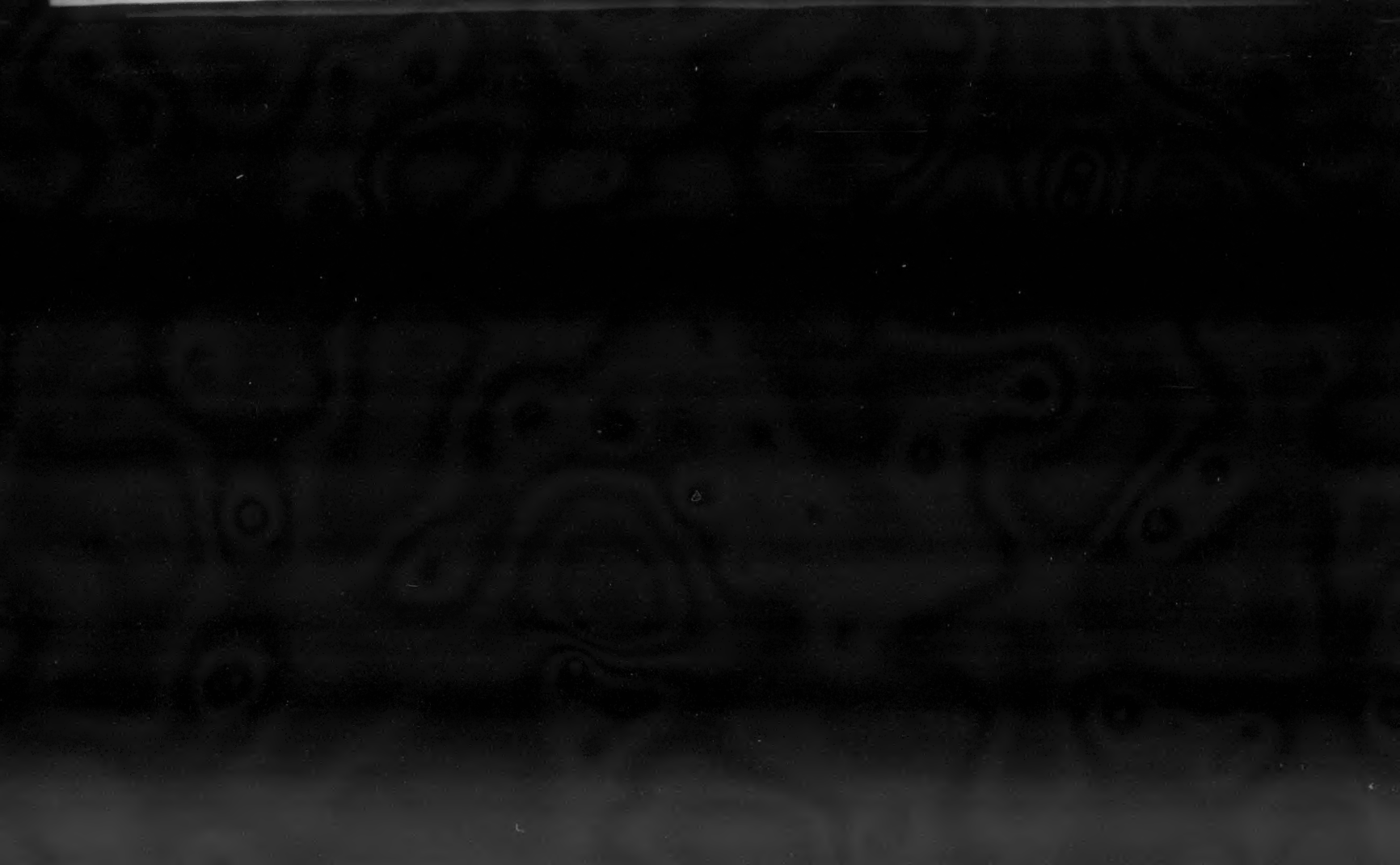
4. The organs have a variety of forms in cross section. The organs of the petiole, the primary organs, are more generally kidney-shaped although they may be circular or oval. The secondary pulvini are more commonly circular or oval in cross section, but different forms occur, varying from flattened

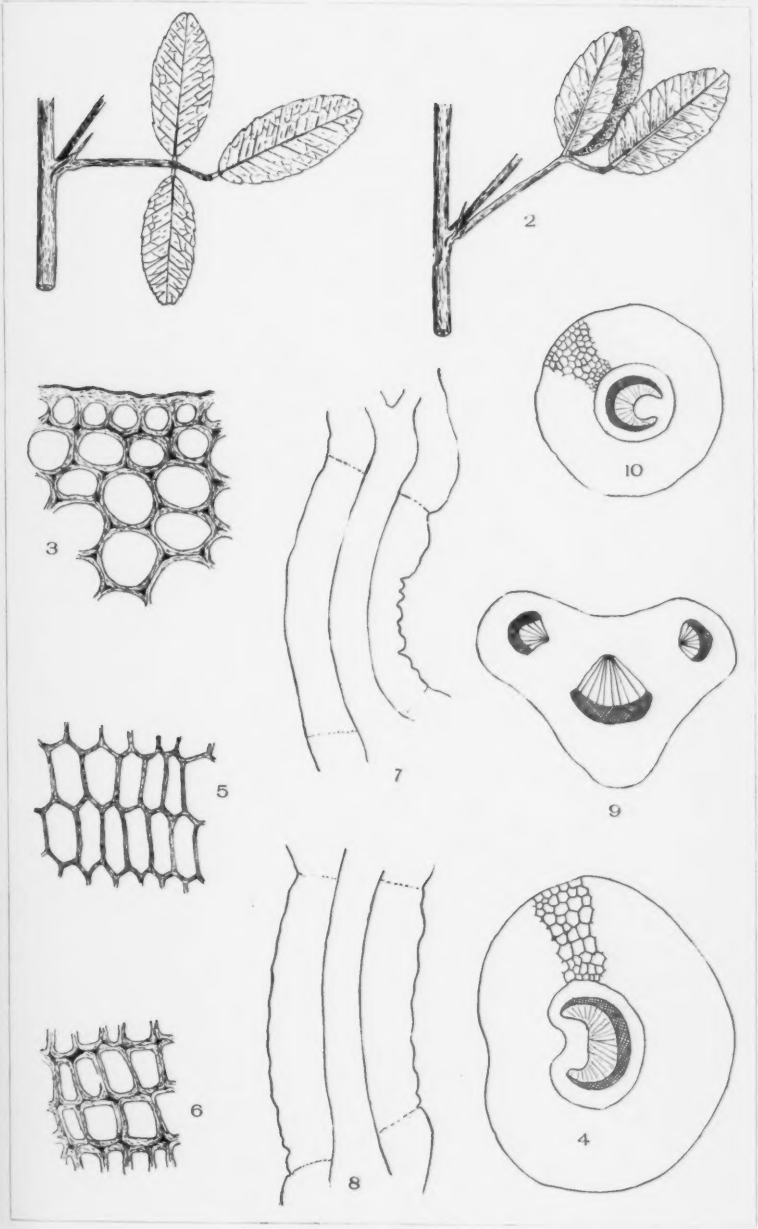
heart shape to almost triangular. In organs which are not circular, the lateral diameter is generally the greater although the exact reverse is the case in a few species. In the majority of organs the length is generally about twice the diameter; a few however were found in which the diameter was equal to the length.

5. The epidermis is fairly well developed when compared with the adjacent epidermis, and *well* developed when compared with the remainder of the motor organ tissue. The cells are shorter in the longitudinal direction than those of the leaf or petiole and their longest diameter is generally in the radial direction. The epidermis is generally covered with trichomes but in no instance could any stomata be found within the limits of the motor organ. The hypodermal cells are always smaller than the parenchyma cells of neighboring parts. They are always very short in the longitudinal direction, while the radial and tangential dimensions are sometimes equal to each other, but as a general rule the radial dimension is the greater. The cell walls are generally thicker than the walls of the adjacent parenchyma cells, and the protoplasm always occupies the periphery of the cells. The cells may be arranged in quite regular longitudinal rows, or on the other hand the arrangement may be quite irregular. The hypodermal tissue is to be regarded homologous with the mesophyll of the leaf. There are three types of hypodermal cells: (*a*), the parenchyma type; (*b*), the collenchyma type, or those which show thickened corners in the cross section; (*c*), a type intermediate, in which the cells have walls that are uniformly thickened.

6. Very few intercellular spaces could be detected and these only near the central stele; they are very small when compared with the intercellular spaces of adjacent parts.

7. The completely developed organ is always traversed by a stele which is entire and completely surrounded by a layer of non-lignified bast fibers. The meristele, in those leaves with primary organs, arises from the axis as three separate strands; these fuse to form the meristele of the organ and so close is the union that it is impossible to make out these three in the cross section. The same may be said of the stele of the secondary organ which is simply a branch of the meristele of the petiole. The stele may be central, or pushed to one side, in which case it is excentric. The remnant of the pith may





HEALD on PULVINI.

be in the center of the stele or it may be represented by the thickened cells at the hilum, which is always on the dorsal side of the organ. Generally speaking the elements of the steles are poorly developed.

8. The well developed organ always shows marked transverse folds even in the diurnal position, which become changed when the curvature of the organ becomes greater or less. Many organs show a compression and distortion of the cells in the region of the transverse folds.

9. Some organs must be regarded as enlargements according to the old idea while others are distinctly contractions. The former is generally the case with primary organs and the latter more commonly with secondary and tertiary organs.

Madison, Wis.

EXPLANATION OF PLATE XXXIV.

All figures except fig. 5 represent Melilotus alba.

Fig. 1. Diurnal position of leaf turned towards the west.
Fig. 2. Nocturnal position.
Fig. 3. Epidermal and collenchyma cells from the cross section of the primary organ.
Fig. 4. Diagram of cross section of primary organ.
Fig. 5. Trifolium repens. Hypodermal parenchyma cells from motor organ. Longitudinal section.
Fig. 6. Cells from longitudinal section of secondary organ.
Fig. 7. Diagram of longitudinal section of secondary organ, nocturnal position.
Fig. 8. The same, diurnal position.
Fig. 9. Diagram of cross section of petiole.
Fig. 10. Diagram of cross section of secondary organ.

Two new ferns from New England.

With some observations on hybridity and nomenclature.

GEORGE E. DAVENPORT.

The unexpected discovery of a new (species) fern, whose characters show unmistakable evidence of hybridization, in Essex county, Massachusetts, by Mr. Raynal Dodge, of Newburyport, is of unusual interest and importance, as it opens up again the question of hybridity among the ferns, a question by no means as yet satisfactorily settled.

Unfortunately absolute proof of hybridity among ferns in nature is beyond our reach and we can only conjecture probable results, with possibility of error in our deductions. We must not assume that because one plant possesses certain characters in common with two others it is necessarily a hybrid, as fundamental structural characters alone are important. The innate tendency of ferns to vary must always be considered, for herein the explanation of many apparent differences and superficial resemblances will be found.

The number of fern hybrids is exceedingly small as it must necessarily be from the very nature of the difficulties surrounding germination even in normal directions.

Asplenium ebenoides is probably the best example of a fern hybrid that we have, the infrequency of its occurrence, the presence always of *Camptosorus* and *Asplenium ebeneum*, and the few plants found in the recorded stations, all going to favor the hypothesis of hybridization; yet even here the difficulty of demonstrating such an hypothesis is almost insurmountable.

The late Wm. H. Leggett wrote to me only a short time before his death that some efforts were being made to test the hybridity of Asplenium ebenoides, but the probabilities are, that the effort, if made, was unsuccessful, as no attempt of that kind has been recorded to my knowledge; and if that fern really derived its origin from two species separated from each other by generic distinctions, the presumption is wholly in favor of its sterility.

Aspidium Boottii is generally considered a hybrid between *Aspidium spinulosum* and *A. cristatum*, but the frequency of its occurrence has oftentimes caused me to doubt the sound-

ness of that view: it is certainly very strange that those two species should be so accommodating as to intercross in so many widely separated stations under such varying conditions and always with such nearly similar results. Besides I have more than once found A. Boottii growing so far away from one or the other of its reputed parents as to almost preclude the possibility of contact.

The fern which I here bring forward for the first time, however, was found growing under such conditions, and exhibits such unmistakable characters, that there is every probability in favor of its hybrid origin. Moreover the successful cultivation in my garden during the past year of plants transplanted from their native habitation has enabled me to watch the growth and development of this fern so closely, and my convictions in regard to it have become so strong, that I should not now expect to find it growing anywhere in nature except in close proximity to *Aspidium cristatum* and *A. marginale*, whose combined characteristics it inherits.

At the same time I recognize the possibility of parent forms dying out, or being exterminated from various causes, while a hybrid or varietal form might continue an independent existence; so that the absence of one or both parent forms from any given locality could not necessarily disprove hybridity, though it might weaken evidence for it.

In the case of the other fern which I also publish here for the first time, it might be claimed with much show of reason that it is a hybrid between *Aspidium Thelypteris* and *A. Noveboracense*, especially from the circumstances under which I found all three ferns growing on Indian Point, Georgetown, Maine; but as there are other and stronger reasons for not accepting that view I have preferred to consider it as a distinct species.

My thanks and acknowledgements are due to Prof. Daniel C. Eaton for having placed in my hands for investigation, with privilege to name and publish, the original specimens of the new hybrid which he received from Mr. Dodge; and also to Mr. Dodge for the privilege of visiting the Essex county stations for both ferns with him, and especially for the valuable critical observations on the habits and characters of both ferns subsequently sent to me by him, and to which I have been greatly indebted while making my own investigations.

In considering the question of nomenclature I have adhered to the Swartzian generic names as Swartz was the first to reduce fern genera to any kind of order, and it is better to keep

his names than to use names of only partial and doubtful application given by writers who knew very little about the subject.

I do not recognize the authority of the makers of the Rochester and Madison codes, nor can I approve of the methods by which final judgment is forestalled, and I do not consider that any one is bound by them.

I believe in the desirability of uniformity, and am ready to sacrifice my own opinions without hesitation whenever Kew and Cambridge, Paris and Berlin shall agree upon some universal basis, but until that time I prefer to be guided by the principles laid down by the illustrious de Candolle, and lately substantially reaffirmed in the recommendations made to the Botanical Section of the American Association in August, 1894, by the committee on the nomenclature of plant diseases.

The name ASPIDIUM was first used by Swartz for the whole genus very nearly as it is now understood, and it ought to be retained as there is no earlier name with the same scope and application.

However if any think otherwise and prefer to divide Aspidium into two genera they can use either Dryopteris, Nephrodium or Lastrea for the Aspidia with reniform indusia, and for the benefit of such persons I have appended to my descriptions synonyms from which they can choose whichever suits them best.

Aspidium cristatum × marginale, n. (hybrid) sp.—Rootstock caudiciform, stout, erect or sub-erect, crown central as in A. marginale, shaggy with large pale brown ovate and ovate-lanceolate scales: fertile fronds $1\frac{1}{2}$ to $2\frac{1}{2}^{ft}$ tall, 4 to 8^{in} broad across the middle of the lamina; sterile fronds one-half to two-thirds as large; stipites 4 to 12^{in} long, stramineous, strongly channelled, usually well clothed, especially below, but sometimes quite naked or sparingly scaly, with pale brown ovate-lanceolate or linear-lanceolate scales: laminæ 10 to 20^{in} long, elliptic-lanceolate narrowing both ways, the lower one-third usually with triangular ovate obtuse pinnæ as in A. cristatum, but sometimes as in A. marginale, the upper two-thirds more like A. marginale in outline with long acuminated deltoid-lanceolate or lanceolate pinnæ and narrowing gradually to the acuminate apex; pinnæ variable, sub-sessile, short-stalked, distant, approximate, alternate or opposite, 2 to $4\frac{1}{2}^{in}$ long, $\frac{3}{4}$ to $1\frac{1}{2}^{in}$ broad at base, narrowing gradually to the acuminate apices, deeply pinnatifid one-half to two-thirds of the way down with oblong or sub-falcate entire or finely serrated

divisions, the basal ones cut nearly to the mid-rib and again pinnatifid with finely toothed lobes, texture sub-coriaceous; rachis stramineous and, as well as the midribs beneath, usually scaly with minute scales and chaff; venation as in A. cristatum, but more strongly depressed on the face and sometimes with the wavy blackish midribs and veins of A. marginale: sori nearer the margins than in A. cristatum, indusia smooth, convex before maturity as in marginale, spores few.

Habitat: Borders of swamps with A. cristatum and A. marginale near the bases of rocky land congenial to the latter. Collected in Boxford, Newbury, and Merrimac, Essex county, Mass., 1892, by Raynal Dodge of Newburyport.

The principal characters by which this fern is to be distinguished from A. cristatum, for which it is most likely to be mistaken, are (1) the character of the rootstock, this having a central crown surrounded by fronds, while in A. cristatum the growth is lateral, extending beyond the fronds; (2) the broader outline of the upper two-thirds of the frond, the longer acuminated apex, and the acuminate pinnæ.

The strongest resemblances to A. cristatum are in the young and sterile fronds, but a careful observation of several plants grown on my own grounds during the past year has shown marked differences that a practiced eye will readily detect.

Mr. Dodge reports finding in August last a single plant in a swamp in Warren, Rhode Island, and it may be looked for wherever A. cristatum and A. marginale grow near each other under favorable conditions.

I have also found it recently (in October), within Middlesex Fells Reservation in Medford, growing under the conditions I have indicated; A. cristatum, A. marginale, and the hybrid near together, with plenty of A. marginale on contiguous ledges, and A. cristatum with its variety Clintonianum, A. Boottii and A. spinulosum scattered throughout a half-acre bit of swampy woodland.

Mr. Dodge notices a disposition on the part of this fern to produce abortive fronds, and I have found that it maintains this disposition under cultivation.

Aspidium simulatum, n. sp.— 1 to $3\frac{1}{2}^{\text{ft}}$ high; rootstock rhizomataceous, wide creeping, slender, brownish: fronds approximate along the extensions or clustered near the growing end; stipites 6 to 20^{in} long, stramineous, brownish at base, sparingly and deciduously scaly; laminæ 7 to 22^{in} long, 2 to $7\frac{1}{2}^{\text{in}}$ broad, oblong-lanceolate, gradually (or in the fertile fronds abruptly) narrowing to the long acuminate pinnatifid

apex, pinnately divided into from twelve to twenty pair of elliptic-lanceolate deeply pinnatifid sessile pinnæ, the lowermost pair as a rule introrse, apices acuminate, the obtuse oblique or oblong divisions entire or slightly toothed, the basal divisions of the lower pinnæ sometimes cut quite to the midrib, margins only partially revolute in fruit, but the whole pinna often conduplicate, texture herbaceous, surfaces, especially along the midribs, finely pubescent, the margins ciliately so, color varying, even in contiguous plants, from light to dark green, turning brown with age; rachis stramineous; venation simple, pinnate, rarely, in one abnormal plant only as far as I have seen, with a few of the lower veins once forked: sori much larger than in either of its congeners, indusia finely glandular, sporangia and spores brown when mature.

Habitat: Woodland swamps, thriving best in deep shade near cool moist hummocks, in beds of sphagnum. Originally collected in Seabrook, Essex co., Mass., about 1880, by Raynal Dodge of Newburyport, and more recently by him there, and also in Salisbury in several localities. Found growing abundantly on Indian Point, Georgetown, Maine, by myself in June, 1893, and in nearly full possession of a deep swamp in the Blue Hills Reservation, Quincy, Mass., Sept. 1894. It has also been collected in Purgatory Swamp, Dedham, Mass., by Judge J. R. Churchill, Sept., 1889, and there are two fronds from Stoneham, Mass., without date, in the collection of ferns bequeathed to the Appalachian Club by the late Mr. E. H. Hitchings. There is every probability of its having been collected many times as A. Thelypteris or A. Noveboracense and botanists should compare their specimens carefully.

This fern is intermediate between *A. Thelypteris* and *A. Noveboracense* showing resemblances to both. There are, however, few species in any one genus that are separated from one another by stronger and more distinctive characters than those which separate it from those two ferns, and the only explanation for its having so long escaped recognition is to be found in the fact that no one would think of looking for, or expect to find among the ferns a new species within the limits of the Manual, such varying forms as might be noticed naturally being referred to the nearest species.

Once attention is called to it, however, its recognition becomes comparatively easy and no one would a second time mistake it for A. Thelypteris, from which it is distinguished

by its simple venation, larger sori and glandular indusia; or for A. Noveboracense from which it is distinguishable by its Thelypteris-like fronds; and from both of which it is soon known by one of those indefinable graces of appearance that sometimes gives character and tone to a plant just as a certain air or carriage oftentimes distinguishes one person from another.

The new fern is also somewhat later than either A. Thelypteris or A. Noveboracense. On Indian Point I found the young crosiers just beginning to unfold while those of A. Thelypteris and A. Noveboracense were from six to eight inches high, and in the Quincy swamp matured plants were fresh and green when A. Noveboracense in the neighboring woodlands had become brown and yellow.

Unlike A. Thelypteris, too, this fern is at its best in the deep shade of cool swampy woodlands, growing naturally and fruiting heavily under conditions where A. Thelypteris is invariably weak growing and sterile.

Mr. Dodge's observations and my own agree very well not only on the points mentioned but in others to which he called my attention, and I am under great obligations to him for the pains he has taken to furnish me with so much valuable information as he has done.

The name which I have given to this fern was selected partly on account of its resemblance to A. Thelypteris and A. Noveboracense, but more especially on account of its remarkable simulation of a narrow woodland form of *Asplenium Filix-fœmina* which almost invariably has conduplicate pinnæ when growing in the sun.

I append the following synonyms of the two ferns here published for the use of those persons who reject Aspidium:

ASPIDIUM CRISTATUM × MARGINALE Davenport.

Dryopteris cristata × *marginalis. Nephrodium cristatum* × *marginale. Lastrea cristata* × *marginalis.*

ASPIDIUM SIMULATUM Davenport.

Dryopteris simulata. Nephrodium simulatum. Lastrea simulata.

NOTE.—It was my intention to have had some outline figures showing the resemblances, differences and special characters of these ferns and their related species, but unavoidable circumstances have compelled me to defer them until some other time.

Medford, Mass.

Some notes on the Leguminosæ of Siam.

GLENN CULBERTSON.

During the latter portion of a few years residence in Siam, I spent many interesting hours in the study of the flora of that almost untouched botanical field. My work was chiefly upon the plants in the immediate vicinity of Bangkok, the specimens having been collected during short walks on the outskirts of the city, or during more or less extended house-boat trips through the many canals intersecting the city and much of Lower Siam.

On examining the list of a collection of about four hundred plants, with a view to comparing the number of species in the seventy orders represented, I was somewhat surprised to find that of these four hundred specimens, which composed the greater part of the flowering plants in that immediate vicinity, seventy-six were of the order Leguminosæ. These species were found in thirty-eight genera; twenty-two of these genera were found under the sub-order Papilionaceæ, eight under Cæsalpineæ, eight under Mimoseæ. This is a very much larger proportion of the last two suborders than is found in a temperate climate. Gray's Manual of Botany gives Papilionaceæ thirty-two, Cæsalpineæ four, Mimoseæ two; while Coulter's Rocky Mountain Botany gives seventeen, two, and one respectively.

A few of these plants have most probably been introduced, but at least ninety per cent are native.

Of the Papilionaceæ the genus *Pterocarpus*, of which there are two species (*P. indicus* and *P. macrocarpus*), is easily first in commercial importance, although last on the list botanically considered. Both species are rather large trees with very hard and beautiful wood, somewhat similar to mahogany but coarser grained. The wood from the roots and from large knots or protuberances is much darker than that of the trunk and is richly variegated. This wood is very highly prized by the Siamese and Chinese for ornamental purposes, and a great many beautiful betel boxes and other valuable articles are made from it. Some very good specimens of this wood, probably bearing the native name "padoo" or "padu", were exhibited at the World's Fair at Chicago. If

distance were not too great a barrier, it would find a ready market in this country for veneering purposes.

Another tree, very common farther north in Siam, is the bastard teak, *Butea frondosa*, named most probably from the striking similarity in the appearance of the leaves to those of the teak tree. It blooms during the dry season in January or February, when the leaves have fallen; and the geat abundance of its large bright orange-red flowers certainly places it first in gorgeousness, and if second in beauty, it is second only to the famous *Poinciana regia*. Even then it is not from lack of beauty in the flowers, but rather from the absence of contrasting foliage.

It is on the twigs and small branches of this tree, as well as the banyan and one or two others, that the little insect, *Coccus lacca*, makes its home, and causes the production of stick lac. Every year a great many long, low-roofed boats from the north come down the Menam to Bangkok, loaded with small branches of Butea frondosa, thickly incrusted with this valuable amber-colored gum.

Plants of the genera *Erythrina* and *Sesbania* are small trees. Of the three species of *Erythrina*, all are very striking in appearance, because of the dense racemes of exceedingly showy coral-red flowers. These also appear during the dry season as do almost all Siamese flowers of any marked beauty.

Sesbania grandiflora is a great favorite of the poorer people, on account of the edible qualities possessed by the young shoots, leaves, and flowers, which are eaten as a vegetable with their curries. Nowhere, I suppose, are there leguminous flowers of larger size than those of this tree. The petals are fully four inches long, and when the flower is open, the tip of the broad recurved standard or upper petal, is at a distance of five or six inches from the tips of the wings and keel. One variety has pure white flowers and another dark red. Man, it seems, is not the only animal that has a liking for these flowers as an article of food. The huge flying fox bats also consider them a great delicacy. On almost any moonlight night, several of them could be seen, from the ever open windows of our dwelling, as they came screeching to one another, and flapping their broad wings (sometimes four or five feet from tip to tip) to alight on the trees, where they hung head downwards or reached out their ungainly thumbs for another flower or branch.

Uvaria crinata, a rather insignificant looking shrub, deserves mention because of its long dense cylindrical racemes of beautiful pink flowers, and the peculiar habit of the pedicels curving inwards after flowering, and pressing the three to five jointed short pods firmly against the strong rachis. I have never seen more dense and enduring racemes of delicate and beautiful flowers than those of this plant. It is certainly worthy of wide introduction as an ornamental plant.

Among the twining Papilionaceæ no species is more delicate and retiring than the wild licorice plant, *Abrus precatorius*. It is sometimes grown as an ornament around native dwellings, partly on account of the flowers and partly on account of the bright scarlet seeds which have a black spot around the hilum. The seeds are prized as ornaments, and are used by jewelers and druggists as one grain weights. There is a strong taste of licorice noticeable in the leaves and stem but especially in the roots, which, judging from the large amounts seen in the shops, are extensively used for the same purpose as the true licorice root.

Several species of *Clitoria* and *Canavalia* are quite interesting, but space will not permit a description. Before noticing some of the more prominent species of Cæsalpineæ, I must mention the shrubby *Flemingia strobilifera*, which grows in clumps resembling the American hazel bush in general appearance. The inflorescence consists of many flowers arranged along each side of a zigzag rachis. The one to three flowered peduncles are enclosed within broad persistent bracts, which in many cases effect a complete exclusion of insects at the time of flowering.

Of the Cæsalpineæ, the most beautiful and probably the best known to the world of all the trees in Siam, the teak excepted, is the *Poinciana regia*. Truly queenly, the prevailing and almost glaring scarlet of its myriads of flowers is delightfully softened by the pale yellow of a single petal in each, and by the rich green of the large, feathery, minutely divided, compound leaves. This tree with its wide-spreading branches can be seen at a great distance, and although in all probability an introduction of many decades past, it has taken a firm hold upon the hearts of the flower-loving Siamese. From a distance the flowering tree strikingly resembles a large fire, which resemblance, no doubt, gave origin to its Siamese name, "the flame of the forest."

Of the genus *Cæsalpinia*, two species are rather peculiar, especially to an inhabitant of a cooler climate. One, *C. bondcealla*, is an extensive woody climber, sometimes reaching to a distance of seventy feet or more on each side of the parent stem, and a jungle where there are many of these plants is next to impassable because of the binding power of the branches, covered with strong recurved prickles.

C. pulcherrima is a small tree frequently planted for ornamental purposes. The copious, wide-spreading, terminal racemes of reddish orange or yellow flowers, cause the tree to appear like a great bouquet. It has been named the "peacock tail tree" by the Siamese.

Of all the genera of Leguminosæ represented, I think no one has a larger number of species than *Cassia*. Of these *C. fistula* is the most noticeable. It is a medium sized tree, which during the hottest part of the dry season is literally loaded with great bunches of large bright sulphur-colored flowers. Here again, the absence of leaves at the time of flowering is conspicuous. The pods of this tree are cylindrical and from fifteen to twenty-four inches long. The seeds of *Cassia tora* are gathered by very poor people, and used as a substitute for coffee.

Saraca cauliflora is a large wide-spreading tree with beautiful clusters of reddish-orange flowers. These flowers are long and tubular and without petals, with seven stamens arising from the throat of the calyx tube.

The tamarind is found in great abundance over all of southern Siam, and is one of the most useful of all the trees in the country. The wood is heavy and hard, and is used for various purposes. The flowers, young leaves, and especially the great abundance of reddish, sour pulp, which surrounds the seeds, are very palatable. The latter furnishes a very agreeable sauce, which is eaten by all classes with rice and curry.

Among the species in the suborder Mimoseæ, *Neptunia oleracea* is one of the most curious. It is a prostrate plant with sensitive leaves and pretty little heads of yellow flowers. Its most peculiar feature, however, is a provision for obtaining light and air, when it happens to grow out over the water, which is very frequently the case. At such times it develops a great abundance of very porous spongy tissue around the stem between the nodes. The ordinary stem is usually less than one-fourth inch in diameter, but when the floats have developed they measure fully an inch across.

Few trees are more handsome than the lofty *Parkia Roxburghii*. Although we hardly expect such large plants in this suborder, some of these trees measure fully seventy feet in height, and with their large twice pinnate leaves and remarkable flowers, they present an appearance not soon forgotten. The inflorescence consists of long pendulous racemes usually with three heads of flowers. These heads are as much as two and a half inches in diameter, and below this there is a neck of similar flowers one inch or more in diameter, and still below this is a fringe of flowers containing long staminodes, which in appearance remind one of the broad ruffs of Queen Elizabeth's time. From these peculiar white heads, each of which contains a hundred or more separate flowers, as many as a dozen or fifteen pods, a foot or more long and one or two inches broad, are produced.

Several *Acacias* are found, one of which, a prickly climber, often binds the tops of high trees together by means of its ramifications, although the stem at base may not be more than three or four inches in diameter. *Mimosa pudica*, with its pretty little pink flower heads and peculiar skeleton-like pods, is only too abundant, and must be classed with such pests as the thistle, nettle, and briar, with us.

In continuance, I could mention the thick woody pods of *Xylia*, which, under the influence of the hot afternoon sun, burst with a loud report and scatter their seeds through the forest to quite a distance from the parent stem, as do the pods of one species of *Milletia*; or I might speak of the delicate clover-like *Desmodium triflorum*, or the huge beans of *Canavalia ensiformis*; but sufficient has been given already.

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BRIEFER ARTICLES.

Intelligence manifested by the swarm-spores of Rhizophidium globosum (A. Br.) Schroeter.—Some algæ, mostly species of Spirogyra, collected during November, at Ithaca, N. Y., were kept in the laboratory in open vessels by a cool window. During an examination of this material Dec. 18th, at 12:50 P. M., several nearly mature zoosporangia were observed attached to a thread of Spirogyra. The zoosporangia were full size and the contents coarsely granular. These were mounted in water in a VanTieghem cell and kept for observation of the escape of the zoospores. At 2 P. M. the protoplasm was segregating into isodiametric masses, the beginning of the zoospores.

There was no opportunity for farther examination of the preparation until 5:30 P. M. of the same day when fortunately the zoospores were escaping, about one-half having already made good their escape. One was at the moment squeezing itself through the rather small ostiolum at the apex of the zoosporangium, while the others were sailing about within it. Lying at the ostiolum, the body of the zoospore against the wall of the zoosporangium, the swarm cell begins amoeboid movements by throwing out the granular portion of the protoplasm at the end opposite from that which contains the hyaline sphere. Beside the extension of this part of the swarm cell the extruded portion also moves about over the inner surface of the wall in the effort to find the opening. When this is accomplished the flowing of the protoplasm continues, moving the body of the cell into the ostiolum. The anterior end of the amœboid cell having passed through the opening, enlarges, thus forming a constricted portion at the point of passage. At first the enlarged portions are of unequal size, the outer part being the smaller. This increases in size as the protoplasm flows through until the two parts are equal, when the cell is dumb bell shaped. Soon the outer portion is the larger and finally the entire mass of the protoplasm has flowed through, and the cell gradually assumes the oval form which it possessed before the attempt at passage. It remained poised at the ostiolum for a few moments as if getting itself in form again during the transition from the amœboid form to the swarm cell form, when suddenly it darted away.

When there were but few swarm cells in the sporangium it was easy to note the maneuvers by which the cell determined the location of the ostiolum. The swarm cell swung violently in irregular circles apparently usually keeping quite free from the walls of the zoosporangium.

Then it would come to rest at any point, there seeming not to be any choice in the location. Amoeboid movements would begin as described above for the cell which was first seen passing through the ostiolum. The extended process would feel about over the inner surface of the wall for the desired opening. After a few moments of vain search, if it did not happen to be located at the ostiolum, it would assume the rounded form again, dart violently away and repeat the circular gyrations. Frequently as it swept across the field it seemed to be of a somewhat flattened form, but this may have been due to slight amoeboid movement during the swarming, produced by the unequal pressure in the water encountered in turning suddenly at a different angle. Again it would come to rest and by amoeboid movements search for the ostiolum, and, failing, would again swarm violently about for another period. This would be kept up until the cell happened to rest close by the ostiolum when by amoeboid movements the search would be rewarded by finding the passage, when the issuance would be slowly made.—GEO. F. ATKINSON, *Cornell University, Ithaca, N. Y.*

The wild rice of Minnesota.—In a recent conversation with Dr. Elliott Coues, the well known naturalist, who had just returned from a visit to the head-waters of the Mississippi, some interesting information with regard to wild rice was brought out and in response to my request for some written notes on the subject Dr. Coues forwarded the appended account of the plant. When it is known that the 32,000 Ojibwa Indians depend upon the native wild rice of northern Minnesota as their staple article of vegetable food, the importance of this plant from an economic stand point is at once apparent, and these facts are suggestive of its further commercial utilization.—FREDERICK V. COVILLE, *Washington, D. C.*

WASHINGTON, D. C., Oct. 28, 1894.

Dear Sir:

Referring to our conversation of yesterday, on the wild rice or *Zizania aquatica*, I was somewhat surprised to be informed that there was anything not generally known about this plant in the observations which I made during my recent canoe-voyage to the sources of the Mississippi river. I comply with pleasure with your request for some notes on this subject.

Wild rice figures as a staple food-product in the earliest historical accounts we have of the various Indian tribes which then inhabited northern Wisconsin and Minnesota. One of these is in fact named from this circumstance. But it would be a great mistake to presume that the case is entirely different now. Rice continues to be a staple commodity among all the bands of Ojibwa Indians on the reservations in Minnesota, both for their own consumption and for sale or barter. It has a quotable commercial value with the traders. The

article is so well known and generally used that it is found convenient in the trade to distinguish our cultivated rice, *Oryza sativa*, as "white rice." During my trip, I subsisted in part on Indian rice, as it is generally called, which I bought of a trader, as one may purchase cultivated rice of his grocer in this city. In northern Minnesota the whites have invented the verb "to rice," and speak of "ricing," i. e., harvesting the crop of wild rice.

This plant grows in profusion nearly throughout the region I traversed in northern Minnesota. Its ubiquity is attested by the unusual number of lakes, rivers, and creeks which are geographically known by its name. Any lake where the plant occurs in harvestable abundance is a "rice lake," whence the transition to Rice Lake as a specific designation is easy and natural. I should imagine this geographical name to be duplicated a score or more times in Minnesota alone, to the great annoyance or confusion of geographers. Many of these waters are also alternatively known by the corresponding Indian name Manomin, in several of the different forms in which this word is spelled by the whites. I never heard the plant called "oats;" it is always "Indian rice," or "wild rice," or simply "rice."

Zizania aquatica is specially luxuriant in still or slow waters with rich muddy bottoms, and grows more sparsely or not at all in grounds where the current quickens or the soil is sandy, or both. Hence it is rather a plant of the lakes than of the streams. I speak more particularly of its growth in harvestable quality and quantity. For there are innumerable places where it appears, scattered in loose patches over large tracts, not growing thick enough, and not "heading up" well enough, to be worth the trouble of gathering. Lakes where a harvestable crop can be gathered are regularly resorted to at the proper season by all the Ojibwa Indians now living on the various reservations in northern Minnesota. Those that I met, of whom I can speak from personal observation, were chiefly the various bands living about Lake Winnibigoshish, Lake Cass, and Lake Bemidji. They generally cultivate their little fields of maize, and potato-patches; but the wild rice which they gather seemed to me to be their staple article of vegetable food. On Aug. 31st, I found the village deserted at Raven's Point, on Lake Winnibigoshish; the inhabitants had "gone ricing." I frequently met canoes en route, whose destination was some rice-field in the vicinity, as evidenced by the pole with a crotch at the end, something like a long-handled pitch-fork, with which they gather the grain. The stalk is never cut as we reap our cereals; the canoe, generally containing two persons, is pushed into the patch of rice, bunches of the heads are bent over the boat; the grains are beaten out, and suffered to fall loose in the canoe, or on a piece of cloth spread to receive them. The period of harvesting is quite brief, as the grains are not loose enough to be beaten out of the heads till they are ripe, and then they soon fall into the water, to be lost, if not promptly garnered.

In paddling up the Mississippi, and many of its tributaries, one becomes aware that he is approaching a rice-lake by the increasing frequency or density of the patches of the plant he passes, alternating with the reeds (*Phragmites communis* or *P. phragmites*) and other aquatic growths, and in some places entirely supplanting them.

These sporadic growths obviously result from seeds which have floated down the current and taken root, perhaps in their turn to give rise to patches of rice of considerable extent, under favorable conditions of soil and water. But these straggling tracts by the river-side are insignificant in comparison with the dense growth of the plant in certain lakes, where it crowds out other vegetation almost entirely. The first crop of rice I happened to see was that on the little lake which forms the discharge of the Pinidiwin river, and is variously known as Pinidiwin Lake, Manomin Lake, and Rice Lake; it enters the Mississippi by a short thoroughfare, from the N., in the N. W. quarter of section 24, township 146 N., range 35 W. of the 5th principal meridian. This body of water, of roundish figure and about a mile in diameter, is almost an unbroken field of rice, growing so luxuriantly that it overtops the head of the canoeman and shuts in his view completely. The deepest part of such a lake is generally open or only broken by the bulrushes (*Scirpus lacustris*); next shallower water favors the prevalence or entire predominance of rice; then comes the shallowest places, generally around the edges, where phragmites grows, to be in turn supplanted by the rank but nutritious grasses of the adjoining haying meadows.

There is a great difference in the stature of the rice, as well as in the length and thickness of the fruiting heads, according to topical conditions of growth. Some of it is only two or three feet high, with small heads two or three inches long, but under the most favorable circumstances the stalk may shoot up to six or eight feet, possibly ten, and the head be as many inches long, nodding under the weight of the ripened grains. The heads are for the most part of a pale green color with a tinge of yellowish, but generally acquire a purplish shade at maturity. The grain makes good food; it is nutritious, tastes very much like cultivated rice, and is cooked by boiling in the same way. But the commercial article—at any rate the sample I saw—has a dirty appearance due to mixture with dark brown or blackish specks which look to casual observation like little bits of sticks. What part of the seed or its husk this represents, botanically, you probably know better than I do. It seemed to me to belong to the grain itself, as if it were the persistent beak of the carpel. I presume that this is what makes them call the cultivated product "white" rice, in distinction from the speckled native product. I understand that different grades or qualities of wild rice are distinguished in the trade, the best article being that which is freest from the dark specks. When boiled, the grains swell up, but not quite like those of our rice, for they acquire a curious curl or twist.

In estimating the total value of this rice-crop as a food-product, we should not forget to take into consideration the myriads of wild fowl which eat it almost exclusively at the proper season, and are eaten in turn by both whites and Indians.

Very truly yours,

ELLIOTT COUES.

Salsola Kali tragus.—As the introduction and dissemination of weeds are receiving much attention from botanists, some facts regarding the first appearance of the Russian thistle in Chicago and vicinity

will be of interest as way-marks indicating its progress eastward. I first noticed it in August, 1890, when a patch of a dozen or more plants was found by Wolf Lake, on the eastern border of the city. They were on a side track of the Pennsylvania R. R., about a mile from the main line. The boundary line between Illinois and Indiana crossed the track so obliquely at this point that both states were represented in the small area they occupied. A month later others were found at Clarke, Ind., a station in the pine barrens, nine miles east of the boundary line, on the main line of the railroad. In a couple of years the plants had spread considerably, and in 1893 were very abundant on the branch of the road running to Hammond and East Chicago. In late autumn one would come upon them blown about the fields as tumble weeds, though as yet but few are found growing in fields. They are well represented on railroads in the southern and eastern portions of the city, and along those crossing the northern part of Lake co., Ind., within three or four miles of Lake Michigan, and probably much beyond. In August, 1894, I found a few at English Lake, Starke co., Ind., seventy miles from Chicago.

The fewness of the plants in each of these localities indicates that the season in which they occurred was about the first of their appearance. The specimens were generally rather small, but examples two or three feet in diameter are not rare now.

These plants were, at the time of finding them, identified as *Salsola Kali* L., and were so published in "The Flora of Cook County, Illinois, and a part of Lake County, Indiana."[1] They were afterwards mentioned under the same name in notes contributed to the BOTANICAL GAZETTE.[2] Subsequent study of the plants and comparison with specimens from Nebraska led to their identification with the variety *tragus*.—E. J. HILL, *Chicago, Ill.*

Lemna Valdiviana.—I have collected and floated out a large number of sheets of *Lemna Valdiviana* Philippi, discovered lately in Randolph, Mass., by Dr. George G. Kennedy. As the station is an interesting one, the plant will be desired by botanists, and I shall be very glad to send it to anybody who may ask for it.—WALTER DEANE, *9 Brewster st., Cambridge, Mass.*

Ruled slides again.—I have found them already in some new ones just received from the Bausch & Lomb Optical Co., Rochester, N. Y. I refer to a slide for a stage microscope. It looks as though, when a slide was hot enough to soften it, a stamp had been pressed on it, making clean creases 20×20^{mm}. I hope they can put the price away down, so that every one will get them.—W. J. BEAL, *Agricultural College, Mich.*—[These have been in the market for several years.—EDS.]

[1] Bulletin of the Chicago Acad. of Sci. **2**: 155. 1891.
[2] l. c. **17**: 248. Ag. 1892.

EDITORIAL.

FOR YEARS the *Journal of Botany* has annually had its fling at the Reports of the Missouri Botanic Garden, and the November number affords the last example of this unpleasant spirit. Usually with little or nothing to say of the scientific papers beyond faint commendation, the editor has devoted his energies to ridiculing the annual flower sermon and the post-prandial eloquence at the annual banquet. Unfortunately, since they are embodied in a will, the eccentric ideas of the dead Englishman have to be carried out as rigorously as his beneficent ones are executed gladly. And we may be permitted to suggest to the editor that his own island house so abounds in transparent follies of the same sort that it is really not becoming in him to pelt our few imported windows.

THIS NUMBER of the *Journal* has also its stale gibe at "the reforming zeal of our transatlantic friends", which it now sees manifesting itself in the formation of the Botanical Society of America. Just what connection the organization of this society has with our "reforming zeal" we imagine it would be hard for the editor to state; but he has thrust in his innuendo and his readers are given to understand that this also is part of a huge farce which is being enacted in the transatlantic wilds in the name of botany.

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THAT SAME reforming zeal, which seems so ridiculous in the eyes of our "British-and-foreign" friend, vaunteth not itself and is not puffed up, spite of the good it is accomplishing and the promise and potency of more. It has a most simple mission; it aims only to secure as great accuracy and uniformity of usage as users of botanical language may feel inclined to adopt. It brings together a considerable number of botanists, who, having in view present usage, agree that it is desirable to follow certain principles in nomenclature, or in citation, or in terminology, or in pronunciation. This agreement coerces no one, it denounces no one, it asks no one to acknowledge its "authority." Still less have "its supporters . a case to prove" as the authors of the Flora of Mt. Desert assert. The parties to the agreement have only to submit its principles, clearly enunciated, to those interested, and let each determine whether he is willing by adopting them to be "dictated to by a comparatively few botanists"; or whether he will follow other principles, or none at all. The choice is a simple one, and our friends that follow not with us need not fash themselves over the source of our authority to cast out devils.

CURRENT LITERATURE.

Laboratory manual of vegetable physiology.

The rapid development of vegetable physiology as a pedagogical subject is marked by the increase in text books and manuals. The latest addition to the list is a work that will be received by every teacher of vegetable physiology with much satisfaction. We refer to the laboratory guide to the physiology of plants by Francis Darwin and E. H. Acton,[1] both of Cambridge University, England. Probably there is no English teacher of botany from whom a work of this kind will be so highly appreciated by botanists in general as from Mr. Francis Darwin. The fame of his illustrious father as a keen and original experimenter has to some extent been transmitted to the son, and has been supported and augmented by many profound and admirable pieces of independent research.

The work is divided into two parts. The first and larger part embraces general physiology, including such subjects as respiration, assimilation of carbon, transpiration, growth, and movements due to irritability. It is separated into 269 experiments, a number so large that the prominent topics which have engaged the attention of original investigators at different times are mostly represented. Often several experiments are devoted to the same inquiry, using different methods, and enabling the student to arrive at more or less accurate results. Although many experiments are arranged for the best apparatus obtainable, yet in each case the same principle is illustrated by experiments requiring only simple and inexpensive devices. Sometimes much is left to the ingenuity and judgment of the student. At times this is a good method, especially when the teacher sees that the student does not lose too much time in ascertaining the requisite or suitable procedure, but occasionally this method appears to be adopted by the authors to escape from the description of a tedious process. On the whole, however, the 269 experiments of the first part are admirably suited to illustrate the present status of vegetable physiology from the physical and mechanical side; they will add a fresh interest to laboratory work in this subject.

The second portion of the work, according to the preface, "treats a particular department of physiology in a more special manner;" that is, it is the part devoted to the chemical side of physiology. It is con-

[1] DARWIN, FRANCIS and E. HAMILTON ACTON:—Practical physiology of plants. 12mo., pp. 321. 42 illust. in the text. Cambridge, Univ. Press, 1894. Macmillan & Co., New York, American publishers. $1.60.

ceived in a very different spirit from the first part, however. It is not separated into experiments, but it is a short treatise upon chemical manipulation. In the opinion of the reviewer it is not a work upon chemical physiology, but upon physiological chemistry, and therefore, while admirably devised for teaching the student chemical methods, is not a legitimate part of a book devoted to botany. It occupies less than one-third of the volume.

It is noteworthy that ecological topics, commonly included to a greater or less extent in works upon vegetable physiology, have been wholly excluded.

A word of commendation is due the publishers for the neat and appropriate way in which the printing and binding have been done. An excellent index increases the usefulness of the work.

Alternation of generations.

This subject has long been a prominent one in both botany and zoology, and a clear, incisive presentation of any part of it will be acceptable to a large number of students. It is rare that any subject of such deep biological import and such wide reaching influence as this is more happily discussed and illustrated than in the recent work on gall flies and their production of oak galls by Dr. Hermann Adler,[1] englished with valuable additions by Charles R. Straton.

The alternate generations of gall-flies in certain species are very sharply marked, so much so that the sexual and agamic forms have been described under distinct genera. Mr. H. F. Bassett, of Connecticut, was the first to point out the probable connection between the two states, or rather to indicate that certain monosexual species were genetically connected with apparently distinct bisexual species. It was due to the labors of Dr. Adler, however, to fully establish the fact, and to work out the details in a considerable number of species by means of careful and patient observations and cultures.

The results have been of more than taxonomic importance. We have before us, in fact, a particularly clear and happy exposition of a number of topics which are commanding wide attention at the present time, such as the purposes of alternate generations, advantages of parthenogenesis, function of polar bodies, and the transmission of hereditary characters. Whoever is interested in such topics should not fail to read this attractively written work.

The botanist as well as the entomologist will find the book helpful.

[1] ADLER, HERMANN:—Alternating generations: a biological study of oak gall flies. Trans. and edited by Charles R. Straton. 12mo., pp. 198. 3 folded col. plates. Oxford, Clarendon Press, 1894. Macmillan & Co., New York, American publishers. $3.25.

in the narrower domain of his specialty. The diversity of form and internal structure of the galls, and the fact that species are often distinguished more from the excrescence on the plant than from the appearance of the insect, should incite botanists to give them attention. The author takes up the evolution of the gall, its minute structure, and the question of its specific form, and brings forward many new facts and views.

The work closes with a list of the Cynipidæ, a bibliography of the subject, and a substantial index. The publishers have done their part well, providing a clear page, excellent colored plates, and an attractive binding.

A laboratory manual of bacteriology.

New manuals for laboratory use in bacteriology have been numerous of late. The last one comes from the University of Michigan, from a laboratory famous for good work. This volume by Dr. Novy[1] is more in the nature of outlines for the Michigan laboratory, than for general use (which will doubtless account for occasional crudities of diction and looseness of statement), yet many teachers will be grateful for its publication. It is interleaved with blank pages for memoranda, which some persons may consider an inconvenient form in which to keep notes. The directions for laboratory procedure are concise, apposite and easily followed. There are diagnoses, occupying a page each, of about twenty-five non-pathogenic forms and thirty pathogenic forms. A series of good lecture outlines, covering the most important topics relating to the general subject of bacteria, are interspersed with the laboratory directions, indicating the ground which the student should cover by lectures, recitations or additional reading.

Minor Notices.

Dr. W. F. Ganong has distributed his paper[1] on the morphology and biology of Cactaceæ, which contains much interesting information concerning a much neglected and most interesting group of plants. Among the results obtained the following are noted: thorns and bristles are shown to be metamorphosed leaves; every leaf possesses an axillary bud which usually remains single, but in Echinocactus, Mamillaria (Cactus), Anhalonium, etc., the growing point is divided, the forking being neither lateral branching nor dichotomy, but a production of permanent tissue between two parts of the growing point;

[1] Novy, Frederick G.:—Directions for laboratory work in bacteriology, for the use of the medical classes in the University of Michigan. 8vo., pp. 209, interleaved. 2 pl. George Wahr, Ann Arbor, [1894]. $1.50.

[1] Ganong, William Francis:—Beiträge zur Kenntniss der Morphologie und Biologie der Cacteen. Inaugural-Dissertation, Munich. 1894.

the grooves are but the stretching out of the pulvini; the sheath in Cylindropuntia is formed from a coalescence of hairs; species of Opuntia, Cereus, Mamillaria possess honey-secreting structures which are always either ordinary or metamorphosed spines; the transverse rings shown by many thorns are due to alternating zones of air-containing and air-free tissue; the bundle systems of all genera are modifications of the typical system seen in Opuntia. By using a combination of vegetative and floral characters the generic relationships are indicated by the usual phylogenetic diagram. It is very valuable for our systematic work to have such careful morphological studies made, as too much of our work is based upon a very superficial morphology.

THE JOURNAL OF MYCOLOGY appears at such long intervals that a new number is especially noteworthy. The last one is no. 4, the final one of volume seven. It contains 146 pages of printed matter and six plates. Forty-eight pages, however, are devoted to an index of volume seven, and thirty-two to the continuation of the general bibliographical index of mycological literature. The latter is admirably done, and if it could only be reissued on cards, would be invaluable. The number is largely devoted to fungicides, and methods and results of their application. A fungus (*Aschersonia tahitensis* Mont.), new to the country, is reported by H. J. Webber as being of possible economic importance in Florida in checking the abundance of such scale insects on orange and other citrous fruits as secrete honeydew, and thus harbor the sooty mold, a serious fungous disease. Interesting field notes for 1892 by Erwin F. Smith, include especially a notice of root tumors of the peach. Nine articles of foreign literature are reviewed.

BORDEAUX MIXTURE as a fungicide is discussed at length by Mr. D. G. Fairchild[1] in a government bulletin from the Division of Vegetable Pathology. The method and completeness of the treatment of the subject much surpass that of the usual bulletin literature, and is greatly to be commended. The history of the adoption of the fungicide, its intimate mode of action, and the toxicology of the mixture are especially interesting parts of the essay. The thorough manner in which the subject is handled in all its bearings makes the work one of the most important contributions relating to fungicides issued up to the present time.

[1] FAIRCHILD, D. G.:—Bordeaux mixture as a fungicide. Bulletin No. 6 of the Division of Vegetable Pathology. 8vo. pp. 55 Washington, Government Printing Office. 1894.

NOTES AND NEWS.

DR. ALBERT SCHNEIDER is studying the lichen flora of northeastern North America at the Columbia College herbarium.

IN *Garden and Forest* (Nov. 21) Mr. Geo. F. Atkinson discusses the Exoascaceæ of stone fruits, and Dr. B. D. Halsted describes and figures a blight of Cosmos.

PROF. L. H. BAILEY completed some months ago the revision of Gray's *Field, Forest, and Garden Botany*, and the book is now in type and ready for issue by the American Book Co.

DR. D. H. CAMPBELL'S forthcoming work on the pteridophytes will be brought out by Macmillan & Co., and will be a book of about 400 pages. It will go into the printer's hands about Christmas.

DR. DOUGLAS H. CAMPBELL presented before the B. A. A. S. at its Oxford meeting a paper on the origin of the sexual organs of the pteridophytes, the substance of which will appear in our next issue.

THE SECOND CENTURY of Ule's *Bryotheca Brasiliensis* is now ready for distribution by Dr. V. F. Brotherus of Helsingfors. The price is the same as that of the first century ($6), of which a few sets still remain unsold.

PROFESSOR C. S. SARGENT in *Garden and Forest* (Oct. 31) describes and figures three hybrid walnut trees growing near Boston. They seem to be hybrids of Juglans regia and Juglans cinerea, and are remarkably intermediate in character.

THE SCREW PINES of Tropical Africa are described by Mr. A. B. Rendle in *Journal of Botany* (Nov.). They seem to keep to the coast line, five species on the west coast, two of which are new, and three on the east coast, all of which are new.

MR. J. C. WILLIS, in *Jour. Linn. Soc.* (30: 284–298) discusses methods of fertilization in species of Brodiaea, Stanhopea, Pimelea, Cotyledon, Hydrolea, Nemophila, and Ziziphora; and also cleistogamy in Salvia verbenacea. Two plates illustrate the paper.

WESTERN CHINA continues to yield a surprising harvest of new species, and in *Journal de Botanique* (Sept.) M. A. Franchet continues his descriptions, among which we note six new species of Corydalis, a new Chelidonium, Acer, Rubus, and two species of Saxifraga.

THE LONG LIST of Scottish Desmidieæ, by John Roy and J. P. Bisset, is brought to a close in the October number of the *Annals of Scottish Natural History*. It is a most valuable compendium, many of the species being critically studied, and quite a number of new species being described.

MR. F. H. KNOWLTON has described (*Bulletin Torr. Bot. Club*, Oct.) a new fossil liverwort from the Yellowstone region. It seems to be questionable whether its relationship is with Marchantia or Preissia, but the new generic name *Preissites* suggests that the burden of proof is with the latter view.

THE GENUS Lathyrus is presented in a paper by Mr. Theodore G. White in the *Torrey Bulletin* (Oct.). In looking over the herbarium material from North and Central America, thirty-three species are recognized, and an artificial key is provided for them. Of these four species are described as new.

IN THE *Torrey Bulletin* for November a number of new plants are described, notably a new Oxalis, by Mr. John K. Small, which has been associated with *O. recurva* in the southern states and with *O. stricta* in the northern states; some new and rare Polygonums also by Mr. Small; five new species from Florida, by Mr. T. H. Kearney; and two new Bolivian genera by Dr. H. H. Rusby.

THE ANNUAL report of the state botanist of New York for 1893 has just appeared. Considerable additions have been made to the herbarium, numerous notes as to the variations of local plants are recorded, and a number of new species are described. In addition to the descriptions of new fungi, a new Carex, which has been known as *C. Emmonsii*, var. *elliptica* Boott, is described by Dr. E. C. Howe as *C. Peckii*.

IN *Bulletin de l'Herbier Boissier* (Sept.) M. C. de Candolle describes some new Asiatic and African Meliaceæ, and gives a plate of his new genus Entandrophragma, which has been referred by Walwitsch to Swietenia. In the same number Prof. R. Chodat presents some extensive studies of certain Protococcideæ, illustrating them with eight colored plates. In the same journal (Oct.) M. R. Buser protests against Ascherson's substitution of Cypripedilum for Cypripedium.

SOME LOWER ORGANISMS found in the exudations from deciduous trees have been studied by Dr. W. Krüger (*Hedwigia* 33:) in pure cultures by the gelatine method. He finds two species of Prototheca, a new genus of a new type of fungus, corresponding to the simplest protococcus-like algæ, and two new species of algæ belonging to the Pleurococcaceæ: Chlorella protothecoides and Chlorothecium saccharophilum. The morphology and physiology of these four species were carefully investigated.

PROF. D. P. PENHALLOW has been studying the anatomy of the wood of North American Coniferæ and will shortly publish a classification of these plants based upon these characters. In connection therewith he has prepared a limited number of sets of type sections which he will issue to subscribers. The sections average about 1^{cm} square, are stained, mounted in balsam and provided with printed labels. Each species or variety is represented by the usual three sections, the entire series embracing 264 slides. The price of the complete series is $120.

THERE APPEARS to be the same difficulty among Germans in writing a text book of botany for beginners as obtains among Americans. A recent review in the Botanische Zeitung of Frank's new text book, entitled *Pflanzenkunde für niedere und mittlere Landwirthschaftsschulen und verwandte Unterrichtsanstalten*, severely criticises the arrangement of the matter, while praising its accuracy. The writer closes by saying that it may be serviceable as a review book for academic classes, but that it is not suitable for lower grade schools, as intended by the author (ein Schulbuch ist es nicht).

THE SMILACEÆ of North and Central America are treated in a posthumous paper by Thomas Morong, published in the *Torrey Bulletin* (Oct.). Following Mr. J. G. Baker, the group is regarded as one worthy of distinct family separation from Liliaceæ. In the New World the family is represented by the single genus Smilax, which has three species in Canada, sixteen in the United States, thirty-two in Mexico and Central America, and about sixty-seven in South America. Of the seventeen species of North America north of Mexico, a new species from Stone Mountain, Georgia, is described, and another from the Florida swamps.

IN THE *Kew Bulletin* (Oct.), among descriptions of new species from Tropical Africa, will be found the description by Mr. Hemsley of a new genus of Umbelliferæ from Mexico, based upon plants collected by Mr. Pringle in July and August, 1894, in the mountains above Oaxaca, and communicated to him by Mr. J. N. Rose. The genus is named *Neogoezia*, being dedicated to Dr. Edmond Goeze of Pomerania, formerly a fellow-student of Mr. Hemsley's. Two other species are referred to the genus, which Mr. Hemsley had heretofore referred to Oreomyrrhis, namely O. gracilipes and O. planipetala of the *Biol. Centr. Amer.* The genus is referred to the Smyrnieæ. This full notice is given for the benefit of American botanists, who are just now very much interested in the Mexican flora, and who are not in the habit of looking into the *Kew Bulletin* for a description of Mr. Pringle's material.

WING-LIKE APPENDAGES on the petioles of a fossil Liriodendron and Liriophyllum are figured and discussed by Mr. Arthur Hollick in the *Torrey Bulletin* (November). He regards these appendages as representing former basilar lobes of the leaf, which in Platanus become "crowded down the petiole until they finally exist as mere stipules," suggesting the question as to the probable origin of stipules. The idea of "crowding down" seems hardly necessary, as the phyllopodium is to be regarded as an axis which has a tendency to develop wing-like appendages at any portion, notably, of course, in the epipodium. If stipules are branches of the hypopodium their origin has simply to do with the branching of that part of the phyllopodium, without any reference to the method of winging to be found in the other regions.

THE EIGHTH annual report of the Division of Forestry gives evidence of commendable industry in this important economic field. To establish a rational forest policy in a comparatively new and hence wasteful country is a very slow process, for it encounters tremendous opposition from ignorance and inertia. It is necessary to collect data so detailed and accurate that there can be no escape from the logic of the situation. It seems that the Atlantic Coast states show 43 per cent. of forest land, the Gulf states 50 per cent., the Lake states 31 per cent., the Interior states 20 per cent., the Rocky Mountain region 10 per cent., and the Pacific coast 30 per cent. The Division holds in manuscript quite a number of important monographs of botanical interest, which, it is to be hoped, may soon be published. The report also contains a full account of German forest management as shown at the World's Fair.

ANNUAL REPORTS for 1893 from three Experiment Stations are upon our table, which have not before been noticed. In the Maine report some studies by the pot method upon the use of phosphates by cultivated plants made by Walter Balentine are illustrated with twenty-one fine plates. In the same report F. L. Harvey writes upon bean and tomato anthracnose, potato and beet scab, and a new weed for the state (*Plantago Patagonica*, var. *aristata* Gray). In the New York report S. A. Beach treats of the life history of Plowrightia morbosa, preventing plum leaf-blight and pear scab, with a partial bibliography of the last topic. In the Wisconsin report F. H. King writes on the distribution of roots in field soils, and E. S. Goff discusses the prevention of apple scab, potato scab and other plant diseases. All these articles are illustrated.

RECENT STATION BULLETINS include three upon the Russian thistle (Ill., no. 35; Iowa, no. 26; and Colo., no. 28), of which the one by the several members of the Iowa Station staff is especially full and interesting. Fungicides and their use in specific diseases receive attention from P. H. Rolfs (Fla., no. 23) and L. H. Pammel (Iowa, no. 24). The cultivation of flowering bulbs in North Carolina as an industry is treated by W. F. Massey (N. C., no. 107). Peach yellows by L. H. Bailey and the prunicolous Exoasceæ of the United States by Geo. F. Atkinson, both from the Cornell Station (no. 75 and 73 resp.) are two interesting bulletins, more than usually well illustrated. Wild or prickly lettuce is discussed by J. C. Arthur (Ind. no. 52), and the injury to stock from eating squirrel-tail grass by Aven Nelson (Wy., no. 19).

MR. AVEN NELSON, botanist to the Wyoming Experiment Station at Laramie, finds that the squirrel-tail grass (or as it is commonly called there "fox-tail"), *Hordeum jubatum*, is a serious pest to stock. The barbed awns break up into pieces, penetrate the gums, especially alongside the teeth, producing swelling and ultimately suppuration of the gums, and ulceration of the jaw bones and teeth, the latter being so loosened as to drop out. If the animal continues to eat hay containing this grass "the disease progresses till the bony tissue of the jaws is disarranged, the ulcers extend to all parts of the jaw bone and it becomes distorted and enlarged. . . . The marrow-filled interior is changed into great cavities filled with the broken awns. This condition may continue till the cavities extend entirely through the jaw and the tightly packed awns protrude till they may be pulled out with forceps or fingers."

GENERAL INDEX.

The more important classified entries will be found under the following heads: *Diseases*, *Floras*, *Host Plants*, *Journals*, *Necrology*, *Personals*, *Physiology*, *Preparations*, *Reviews*.

Names of synonyms are printed in *Italics;* names of new species, etc., in **bold face.**

A

A. A. A. S., Brooklyn meeting, 362; papers before Botanical Club, 382; papers before Section G, 369; proceedings of Section G, 362.
Abrus precatorius, 500.
Absorption of water, 136.
Abutilon Avicennæ, 482, 489.
Acacia, 502; Julibrissin, 292; Lophantha, 292.
Acer, in Michigan, 370.
Aconitum, noveboracense, 346; runcinatum, 346.
Acrostichum, conforme, 389; latifolium, 389; recognitum, 389; venustum, 389.
Adiantum, *pentadactylon*, 389; trapaesiforme, 389.
Æchmea **Friedrichsthalii,** 263.
Ægiceras majus, 338.
African plants, 413.
Algæ, 425, 426, 514; Minnesota, 246; preparations of, 210; sets of, 472; swarm spores of, 503.
Alternation of generations, 510.
Amaranthus, **acutilobus,** 320; **albomarginatus,** 318; *albus*, 316; Berlandieri, 268; **Bigelovii,** 271; blitoides, 315, vars. **densifolius,** and **Reverchoni,** 315; Blitum, 317; **bracteosa,** 314; californicus, 318; carneus, 317; caudatus, 314; chihuahuensis, 271; *Chlorostachys*, 314; crassipes, 315; crispus, 319; deflexus, 319; emarginatus, 319; fimbriatus, 270; graecizans, 316, var. **pubescens,** 317; Greggii, 271, var. **Muelleri,** 272; hybridus, 314; *hypochondriacus* 314; *leucospermus*, 314; lividus, 318; *obovatus*, 313; Palmeri, 272, var. **glomeratus,** 272; polygonoides, 269; Powellii, 313; Pringlei, 270; pumilus, 320; retroflexus, 313; **scleropoides,** 316; spinosus, 315; squarrulosus, 270; synopsis of, 267; Torreyi, 272, var. **sufruticosus,** 272; urceolatus, 269, var. **Jonesii,** 269; *venulosus*, 270; viridis, 319; *viridis*, 319, 320; *Wrightii*, 313.
Amblyogyne polygonoides, 269; *squarrulosa*, 270; *urceolata*, 269.
Amblystegium **Holzingeri,** 240.
Amentiferæ, embryology of, 299, 427.
Anabæna, parasitic in Cycas, 25.
Aneimia, hirsuta, 390; *tenella*, 390.
Anhalonium, 371.
Anthericum **apodastanthum,** 265.
Anthocerotales, 358.
Anthurus borealis, 471.
Aphanorhegma serrata, 379.
Archegoniates, a theory of strobilus, 476.
Archenema, 19.
Archidium Hallii, var. **minus,** 237.
Arcyria macrospora, 89.
Ardisia **paschalis,** 5.
Arisaema triphyllum, 464.
Artemisia stelleriana, 253.
Aschersonia tahitensis, 512.
Aspergillus niger, 210.
Aspidium, aculeatum, 390; Boottii, 492; **cristatum × marginale,** 494, 497; *marginale*, 200; melanostictum, 390; noveboracense, 496; setosum, 390; **simulatum,** 495, 497; spinulosum, 390; Thelypteris, 496.
Asplenium, cicutarium, var. **paleaceum,** 390; ebenoides, 492; hastatum, 390; pumilum, var. **lacıniatum,** 390; rhizophyllum, var. **proliferum,** 390; **rubinum,** 391; Shepherdii, 391; Trichomanes, 391.
Assyrian monuments, plants of, 82.
Aster, adnatus, 36; concolor, a compass plant, 35; and Solidago, 211; tardiflorus, 200.
Attraction spheres, 445.
Auxanometer, 420; for measuring growth in thickness, 113.
Avicennia officinalis, 327.
Azolla filiculoides, 87.

B

Badhamia hyalina, 246.
Bacteria, effect of formic aldehyde, 86; laboratory manual, 511; literature of, 425.
Bacterium Zopfii, 344.
Baptisia, australis, 42; a hybrid, 42; leucophœa, 42.
Begonia rubra-grandiflora, 298.
Betulaceæ, embryology of, 427.
Blaschka glass models, 144.
Botanical Congress, Madison, 386, 423.
Botanical Society of America, 388.
Botanischer Jahresbericht, 248, 250.
Botany, departments of, 345.
Botrychium, matricariaefolium, 391; ternatum, 391.
Brachythecium, reflexum, var. **Demetrii,** 239; salebrosum, var. **Waghornei,** 238; **suberythrorrhizon,** 238.
Brown University, dept. of Botany, 253.
Bruguiera, caryophylloides, 328; eriopetala, 328; gymnorhiza, 327.
Bryotheca Brasiliensis, 513.
Bryum bimum, var. **atrotheca,** 238.
Bulb, development in Erythronium, 61.
Butea frondosa, 499.

C

Cabralea, **insignis,** 1; pallescens, 2.
Cactaceæ, affinities among, 371; leaf-like, 473; morphology of, 511; revision of, 300.
Caesalpinia, bonducella, 501; pulcherrima, 501.
Calcium oxalate, role of, 427.

Calochortus, macrocarpus, 336; **pavonaceus,** 335.
Canavalia ensiformis, 502.
Carbohydrates, origin of, 169.
Card index, 345.
Carex Peckii, 514.
Caryophyllaceæ, 343.
Cassia, fistula, 501; of North America, 301; tora, 501.
Cedrela **impari-pinnata,** 4.
Cell, literature of, 344.
Centrosomes, 445.
Centrospheres, 425, 445.
Ceratiomyxa, mucida, 377; plumosa, 376; swarm spores of, 375.
Ceratium hydnoides, 377.
Cercis canadensis, leaf movement in, 215.
Chalara paradoxa, 378.
Charts, the Dodel-Port, 128.
Cheilanthes, *alabamensis,* 395; farinosa, 395; microphylla, 395; speciosissima, 392.
Chlorella protothecoides, 514.
Chlorothecium saccharophilum, 514.
Chromatophores, in seeds, 407.
Chroomonas Nordstedtii, 100.
Chrysomyxa, **Arctostaphyli,** 303; **Chiogenis,** 303; **Gossypii,** 187; Ledi, 303; Pyrolæ, 303; Rhododendri, 303.
Chrysopsis villosa, 158.
Classification, chart of larger groups, 85; phanerogamic families, 372.
Clathrus columnatus, 37.
Clematis, Pitcheri, 105; virginiana, 103.
Climate, relation to plants, 413.
Color bodies, in seeds, 407.
Color description of flowers, 15.
Compass plants, 35, 158, 251.
Completoria complens, 467.
Compositæ, as compass plants, 35.
Coniferæ, wood of, 514.
Cordyceps militaris, 135.
Cork, 193.
Cornuella Lemnæ, 187.
Cribraria, minutissima, 397; purpurea, 91.
Cryptoglena **americana,** 101.
Cryptomonas, cyana, 100; marina, 100; ovata, 100; polymorpha, 100.
Cunila mariana, as frost plant, 41.
Cuphea **Heydei,** 256.
Cuscuta, haustoria of, 46, 124, 331.
Cyanophyceæ, a new motile cell, 96.
Cycas revoluta, 25.
Cyperus rotundus, 472.
Cystosiphon pythioides, 376.

D

Dedoublement, Arisaema, 464; Podophyllum, 465; Trillium, 460; Ulmus, 462.
Desmideæ, 167, 513.
Desmodium triflorum, 502.
Diachaea leucopoda, 246.
Dicksonia rubiginosa, 392.
Dicranella **leptotrichoides,** 237.
Dioscorea **dicranandra,** 13.
Diseases, apples, 84; beets, 168, 379; Bordeaux mixture, 512; Cosmos blight, 513; spraying with fungicides, 420; tomatoes, 84; violets, 84; watermelon, 373.
Distribution of seeds by birds, 159.
Doassansia, deformans, 185; *Gossypii,* 187; **intermedia,** 185; martianoffiana, 185; occulta, 185; opaca, 185; punctiformis, 186; **ranunculina,** 416.
Dolichos sinensis, 292.
Dracaena marginata, role of pericycle, 67.
Drugs, source of native, 47.
Dryopteris, *cristata* × ***marginalis,***497; marginalis, 200; *simulata,* 497.

E

Economic botany, 160.
Embryo, nourishment of, 327.
Encalypta, ciliata, 379; longipes, 379; Macounii, 379.
Endosperm in mangroves, 327.
Entandophragma, 514.
Enteridium Rozeanum, germination of, 92.
Entyloma, compositarum, 187; crastophilum, 187; Nymphææ, 189.
Epiphegus virginiana, 214.
Equisetum in carboniferous, 71.
Erythrina, 499.
Erythronium, development of bulb, 61.
Ethereal oils in plants, 168.
Euastrum pinnatifidum, 58.
Eudorina elegans, 281.
Eurhynchium Sullivantii, var. **Holzingeri,** 239.
Eustichia norvegica, fruiting, 384.
Euxoüs, emarginatus, 320; *viridis,* 319.
Evolution, in angiosperms, 372; of Hepaticæ, 347; of plant life, 417; struggle for existence, 380; variability, 380.
Exsiccatæ, Algæ, 472; Uredineæ, 46.

F

Ferments, in Aspergillus, 210; diastatic, 473; vegetable, 68.
Ferns of New England, 492.
Fertilization of petunias, 336.
Fibro-vascular bundle, 191.
Fissidens, exiguus, 238; **falcatulus,** 237.
Flemingia strobilifera, 500.
Floras, Africa, 167, 425; China, 513; Florida, 37, 424; Georgia, 33; Greenland, 78; Guatemala, 1, 255; Idaho, 117; Illinois, 415; India, 86; Lake St. Clair, 342; Lower California, 212; Mexican, 39, 386, 389; Minnesota, 86; Mt. Desert, 385; Nebraska, 84, 469; New York, 300; Portugal, 209; Texas, 210; Vermont, 200; Wisconsin, 79.
Fluckigeria, 375.
Forestry, report on, 515.
Frasera, **caerulea,** 118; **montana,** 119.
Frost plants, 40, 120, 321.
Fuligo septica, 246.
Fungi, entomogenous, 129; of Florida, 37; new genus of mucedinous, 244; sexual reproduction of, 127; of Wisconsin, 415.
Fusarium niveum, 374.

G

Garden, Buitenzorg, 74, 421.
Gases, movement in rhizomes, 369.
Gaura parviflora, 158.
Gilia grandiflora, 119, var. **diffusa,** 120.
Gloiotrichia echinulata, 425.
Grafting, herbaceous, 473.
Grindelia squarrosa, 415.
Guarea, **Luxii,** 2; **Palmeri,** 39.
Guatemalan plants, 1, 255.
Guttiferæ, Vesque's revision, 164.
Gymnogramme, Calomelanos, 392; chaerophylla, 266; Ehrenbergiana, var. **muralis,** 392; *peruviana,* 392; schizophylla, 266; **sciatraphis,** 266; trifoliata, 392.

H

Haustoria, of phanerogamic parasites, 46, 124, 331.
Heat, radiation and absorption by leaves, 85.
Heisteria, **costaricensis,** 255; salicifolia, 255.
Helianthemum, 302.
Hemiarcyria rubiformis, 246.
Hepatica triloba, abnormal, 338.
Hepaticæ, evolution of, 347; new fossil genus, 513; notes on, 273.
Herbarium, Donnell Smith, 124; oven for drying, 166; Parry, 83; Univ. of Minn., 426; U. S. Nat., 121, 424.
Heteranthera, graminea, 179; limosa, 179; reniformis, 179.
Honey dew, 253.
Hordeum jubatum, 516.
Horticulture, World's Soc., 48.
Host plants, Arctostaphylos Uva-Ursi, 303; Aspidium falcatum (prothallium), 468; Aster Novi-Belgii, 187; Atriplex sp., 306; Cacalia reniformis, 415; Caltha biflora, 304; C. leptosepala, 304; C. palustris, 304; Carex vulpinoidea, 304; Chiogenes serpyllifolia, 303; Chrysopsis villosa, 305; Elymus sp., 305; Lythrum hyssopifolium, 186; Muhlenbergia sylvatica, 415; Nuphar advena, 188; Nymphaea odorata, 188; Panicum Crus-galli, 189; Phlox divaricata, 306; Populus tremuloides, 380; Potamogeton Claytonii, 185; Potentilla gelida, 305; Pteris argyria (prothallium), 468; P. cretica (prothallium), 468; Ranunculus multifidus, 416; Rubus saxatilis, 167; Sagittaria variabilis, 185, 186; Stellaria media, 296; Zizania aquatica, 188.
Hybrids, Baptisia, 42; ferns, 492; walnuts, 513.
Hydnangium Ravenelii, 37.
Hypericum, angulosum, 35; cistifolium and insects, 109.
Hypnum, 421; giganteum, var. **labradorense,** 240.

I

Index, card, 345.
Indiana Acad. Sci., 47, 249, 470.
Insectivorous plants, 213.
Insects, and flowers, 103, 128; and oak galls, 510.
Iowa Acad. Sci., 84.
Ipomoea fistulosa, var. **nicaraguensis,** 256.
Isaria farinosa, culture of, 129.
Isopyrum biternatum and insects, 103.

J

Journals and serial publications: Agric. Sci., 46; Am. Jour. Sci., 85; Am. Micr. Jour., 210; Amer. Nat., 85, 168, 169, 212, 424, 472; Annals Bot., 46, 68, 124, 213, 331, 476; Annal. Jard. Bot. Buiten., 327; Ann. Scottish Nat. Hist., 254, 513; Archiv. f. Hyg., 344; Ber. d. deut. bot. Gesell., 213, 253, 421, 427; Bol. Soc. Brot., 209; Bot. Central., 344; Bot. Notiser, 209; Bull. Exper. Sta., (Ala.) 88, 427, (Ariz.) 427, (Coldo.) 516, (Conn.) 213, 344, (Fla.) 88, 516, (Ill.) 516, (Ind.) 516, (Iowa) 516, (Kan.) 88, 346, (Mass.) 88, 346, (Me.) 516, (Minn.) 213, 426, (N. C.) 516, (N. D.) 215, (Neb.) 82, 88, (Nev.) 88, 426, (N. J.) 82, 88, 420, (N. Y.) 88, 346, 427, 516, (R. I.) 213, (Vt.) 82, 213, (Wash.) 88, (Wis.) 88, 127, 346, 516, (W. Va.) 83, (Wyoming) 88, 516; Bull. l'Herb. Boiss., 167, 173, 301, 425, 514; Bull. Me. State Coll., 80; Bull. Bot. Soc. France, 67; Bull. Torr. Bot. Club, 83, 168, 211, 301, 423, 426, 513, 514, 515; Bull. Univ. Iowa, 79; Bull. Univ. Minn., 210; Bull. U. S. Depart. Agric., 344, 420, 421, 512; Bull. U. S. Geol. Surv., 209, 419; Centr. f. Bak. u. Par., 345; Compt. Rend., 66, 71, 253, 284; Contrib. U. S. Nat. Herb., 80; Erythea, 167, 211, 301, 423, 424; Flora, 301, 471; Forschungs-Ber. etc., 211; Forst. Natur. Zeit., 409, 424, 472; Gard. and Forest, 212, 301, 388, 423, 513; Grevillea, 423; Harp. Month., 128; Hedwigia, 82, 514; Jahrb. f. wiss. Bot., 473; J. H. U. Studies, 47; Jour. Bot., 84, 167, 168, 301, 425, 513; Jour. de Bot. 167, 209, 425, 513; Jour. Cin. Soc. Nat. Hist., 125, 167; Jour. Geol. 386; Jour. Linn. Soc., 83, 513; Jour. Mycol. 512; Jour. Roy. Hort. Soc., 125; Kew Bull., 86, 128, 301, 515; Le Botaniste, 127, 388; Lilly's Bull., 47; Meehan's Month., 301, 346; Mem. Bost. Soc. Nat. Hist., 471; Micr. Bull., 209; Minn. Bot. Studies, 86, 212, 252, 420; Pop. Sci. News, 344; Proc. Amer. Acad., 343; Proc. Amer. Micr. Soc., 214; Proc. Ass. Am. Agric. Coll. 46, 423; Proc. Camb. Phil. Soc., 84; Proc. Ohio Hort. Soc., 345; Proc. Philad. Acad., 78; Proc. Wash. Biol. Soc., 78; Rep. Div. Forestry, 515; Rep. Mo. Bot. Gard., 78, 342; Rep. N. Y. State Bot., 78, 514; Rev. Bryol., 423; Rev. gen. Bot., 473; Rev. Mycol., 424; Science, 209, 210, 211; Trans. Con. Acad., 125; Trans. Iowa Hort. Soc., 127; Trans. Linn. Soc., 299; Trans. S. Afr. Phil. Soc., 413; Trans. St. Louis Acad., 78; Trans. Wis. Acad., 79, 419; Zeit. f. Pflanz., 472; Zoe, 209, 212.
Juncus marginatus, its varieties, 78.
Juncodes, synonymy of, 208.
Jungermaniales, 355.

L

Laboulbeniaceæ, 125.
Lactuca, sativa, 380; scariola, 36, 158, 380.
Lastrea, cristata × *marginalis,* 497; *simulata,* 497.
Lathyrus, 514; **pauciflorus,** 335.
Leaves, causes of arrangement, 473; developed in sun, 45.
Lechea, 302.
Leguminosæ, pulvini of, 482; of Siam, 498.
Leitneria floridana, 342.
Lemna Valdiviana, 468, 507.
Liatris, graminifolia, 35; scariosa, 35.
Linum virginianum, 36.
Liriodendron, fossil, 515.
Liriophyllum, fossil, 515.
Logan, James, sketch of work, 307.
Lophopappus, 375.
Lophophora, 371.
Lophotocarpus, 343.
Lupinus, angustifolius, 292; luteus, 292.
Lycoperdon, acuminatum, 37; *leprosum,* 37.

M

Maclura aurantiaca, poisonous, 200.
Maize, 44; varieties of, 426.
Mamillaria, 371.
Maples, of Michigan, 370; winter condition and synonymy, 78.
Marchantia as a type, 387.
Marchantiales, 353.
Mechanical resistance, influence of, 149, 191, 229.

Mechanics of growing plants, 71.
Melandryum, 84.
Meliaceæ, 514.
Melilotus alba, motor organs of, 483.
Mengea californica, 318.
Metanema, 19.
Metzgeriaceæ, 361.
Mexican plants, 39, 386, 389.
Micrasterias, foliacea, 56; furcata, 58; oscitans, 58; pinnatifida, 58; pseudofurcata, 60.
Milletia, 502.
Mimosa pudica, 502.
Monocotyledons, function of secondary tissues, 66.
Morong, Dr. Thomas, sketch of, 225.
Mosses, a hybrid, 379; new species of, 237.
Mounting microscopic preparations, 45.
Myriophyllum scabratum, 200.
Myrrhidendron Donnellsmithii, 466.
Myxomycetes, 397; of central N. Y., 89; germination of, 245.

N

Naegelia, observations on, 49.
Naegeliella Reinschii, 54.
Names, popular American, 429.
Necrology: Bentley, R., 82; Boehm, Dr. Jos., 45; Hasskarl, J. K., 127; Lockwood, Samuel, 82; Morong, Dr. Thomas, 209, 225; Spruce, Dr. Richard, 82, 168; Traube, Dr. Moritz, 474; Weiss, Dr. G. A., 253.
Nectandra **Heydeana**, 262.
Negundo aceroides, 253.
Neogoezia, new genus of Umbelliferæ, 515.
Nephrodium, cristatum × *marginale*, 497; *simulatum*, 497; *tetragonum*, 390.
Neptunia oleracea, 501.
Nitrogen, fixation of free, 284, 426.
Nomenclature, 126, 170, 493; of plant diseases, 366.
Nostoc commune, 30.
Notholaena Grayi, 393.
Nucleolus, 421.
Number of plants, 169.
Nymphaeaceæ, forms of leaves, 127.

O

Oaks as weeds, 33.
Œnothera **idahoensis**, 117.
Ohio Acad. Sci., 344.
Oils, essential, 418; ethereal, 168.
Olpitrichum carpophilum, 244.
Onoclea, fertile and sterile leaves, 374.
Oospora scabies, 168.
Ophioglossum, crotolophoroides, 393; reticulatum, 393; vulgatum, 393.
Oreopanax **Taubertianum**, 4.
Osmunda regalis, 393.
Ostrya, a new, 212.
Oxalis, 514; corniculata, pulvinus of, 222, 482.

P

Palmettoes, fossil in Fla., 37.
Parasitism of Epiphegus, 214.
Parenchyma, fundamental, 154.
Parkia Roxburghii, 502.
Pediianthus **macradenius**, 263.
Peltostigma, **pentaphyllum**, 1; pteleoides, 1.
Peperomia, **cobana**, 260; **guatemalensis**, 10; **Heydei**, 9; **Luxii**, 260; **macrophylla**, 8; **sanfelipensis**, 9; **santa-rosana**, 10; **sisiana**, 9; **violaefolia**, 8.
Pepper, black, cultivation of, 423.
Peronospora, **phlogina**, 306.
Personals: Agardh, 83; Atkinson, 45; Avetta, 302; Bailey, 513; Baldini, 302; Bebb, 127; Bonnier, 127; Brandegee, 209; Campbell, 209, 513; Carleton, 167; Cesati, 302; Cook, 45; Coulter, 424; Curtiss, 424; Delpino, 302; Donnell-Smith, 82; Fernald, 253; Forbes, 302; Franceschi, 46; Giessler, 302; Greene, 424; Hicks, 82; Hopkins, 83; Kearney, 344; Klein, 302; Krueger, 302; Kuntze, 127; Lovisato, 302; Macoun, 253; Mattirolo, 302; Molisch, 472; Morong, 127; Newcombe, 82; Orcutt, 127; Otto, 302; Palmer, 472; Saposchnikoff, 302; Sarauw, 302; Schneider, 513; Scott, 302; Scribner, 214, 388; Sorauer, 127; Spalding, 82; Willis, 83, 302; Woods, 82; Zacharias, 302; Zimmermann, 423.
Petunia, cross-fertilization of, 336.
Phaseolus vulgaris, rhizobia of, 29.
Phoebe **amplifolia**, 261.
Photeolic movements, 477, 480.
Phragmidium **biloculare**, 305.
Phragmites, communis, 505; phragmites, 505.
Physcomitrium turbinatum, 379, var. **crassipes**, 238.
Physiology, absorption of water, 136; action at a distance, 406; adaptation to climate, 413; age of tubers, 473; American apparatus, 339; auxanometer, 420, for thickness, 113; Bacterium Zopfii, 344; calcium oxalate, role of, 427; Darwin's manual, 509; in Depart. Agric., 424; diastatic enzymes, 473, electroculture, 88; gases in rhizomes, 369; geotropism of roots, 475; germinating seeds, 333; growth influenced by traction, 293; haustoria of Cuscuta, 331; leaf arrangement, causes of, 473; leaf movement in Cercis, 215; mechanical resistance, influence of, 149, 191, 229; motor organs, 478; nitrogen, fixation of free, 284; nourishment of embryo in mangroves, 327; Oel's manual (translation), 301; plea for research, 85; pulvini and photeolic movements, 477; registering balance, 420; roots penetrating tissues, 475; work of James Logan, 307.
Pilea, **irrorata**, 11; **pansamalana**, 10; **pleuroneura**, 12; **quichensis**, 12; **riparia**, 11; **senarifolia**, 12.
Pines, screw, of Africa, 513.
Pinus, apacheca, 301; australis, 33; Donnell-Smithii, 13; Lumholtzii, 386; mitis, 33; rigida, primary foliage of, 378; Taeda, 33; wood of, 409.
Piper, **Donnell-Smithii**, 259; **flavidum**, 258; **Heydei**, 7; **Luxii**, 5; **Santa-rosanum**, 258; tuberculatum, 8; **Tuerckheimii**, 258; **uspantanense**, 6; **variabile**, 259; **yzabalanum**, 7.
Pitcairnia **puberula**, 264.
Plantago patagonica, 516.
Plecosorus mexicana, 392.
Pleodorina californica, 282; in Illinois, 383; in Indiana, 383.
Plucheas as frost plants, 120.
Podophyllum peltatum, 465.
Poinciana regia, 500.
Poisonous plants, 159, 200.
Polycystis pallida, 96.
Polygala verticillata, 482.
Polypodium, angustifolium 393; *ensifolium*, 393; heteromorphum, 393; lepidopteris, 393; Martensii, 394; pectinatum, 394; **petiolatum**, 394; Phyllitidis, 394; pilosissimum, 394; Plumula, 394; *variabile*, 393; vulgare, 394.
Pontederiaceæ, histology of, 178.

Pontederia, cordata, 179; crassipes, 178.
Preissites, 513.
Preparations, of algæ, 210; formic aldehyde in, 86; large and thick sections, 48; mounting microscopic, 45.
Prizes, Belgian Academy, 472.
Protococcus infusionum, development of, 334.
Protonema, 19.
Protoplasm, continuity in fungi and algæ, 47; energy of living, 302.
Prototheca, 514.
Prunus Watsoni, 210.
Psoralea, 211.
Pteridophytes, relationships among, 87.
Pterocarpus, indicus, 498; macrocarpus, 498.
Puccinia, **areolata**, 304; Calthæ, 304; Chloridis, 305; dispersa, 472; graminis, 346; **hyalomitra**, 304; malvacearum, 468; Peckiana, 167; rubigo-vera, 346; Treleasiana, 304; **vulpinoidis**, 304; Zopfii, 304.
Pulvini, comparative histology of, 477.
Pylaisia polyantha, var. **coloradensis**, 238.
Pythium, Cystosiphon, 376; DeBaryanum, 376; entophytum, 376; *Equiseti*, 376; proliferum, 375; reptans, 375; swarm spores of, 375.

Q

Quercus, Catesbaei, 34; Leana, 171; nigra, 34; wood of, 411.

R

Radishes, growth of in relation to seed, 369.
Rafinesque, proposed life of, 474.
Ranunculus, abortivus and insects, 108; acris as poisonous, 159, 472; fascicularis and insects, 107; septentrionalis and insects, 105.
Resins in plants, 168.
Reticularia umbrina, germination of, 245.
Reviews: Adler's "Alternation of generations," 510; Atkinson's "Biology of ferns," 165; Bailey's "Botanical note-book," 470; Benson's "Embryology of Amentiferæ," 299; Bower's "Practical botany," 386; Boyer's "Laboratory manual," 203; Cobb's "Australian fungi," 166; Coulter's "Cactaceæ," 300, "Texan botany," 343; Coville's "Botany of Death Valley," 76; Crombie's "British lichens," 300; Darwin's "Practical physiology," 509; De Cordemoy's "Functions of secondary tissues," 66; "Role of the pericycle," 67; Del Castillo's "French Polynesia," 77; Dennis' "Syllabus," 166; Dodge's "Laboratory guide to biology," 204; Ganong's "Cactaceæ," 511; (Mrs.) Gray's Letters of Asa Gray," 122; Green's "Vegetable ferments;" Greene's "Californian manual," 162; Harshberger's "Maize," 44; Hitchcock's "Manhattan plants," 470; Kiaerskou's "Myrtles of Brazil," 44; Massee's "Evolution of plant life," 417; Novy's "Laboratory manual of bacteriology," 511; Oel's "Plant physiology" (MacDougal transl.), 341; Pfeffer's "Mechanics of growing plants," 71; Potter's "Agricultural botany," 205; Power's "Essential oils," 418; Raceborski's "Cabombeæ and Nymphaeaceæ," 470; Rand and Redfield's "Flora of Mt. Desert," 385; Robinson's "Contributions," 343; Sprengel's "Mystery of nature," 207; Trelease's "Gayophytum and Boisduvalia," 166; Univ. of Nebraska's "State flora," 469; Vesque's "Revision of Guttiferæ," 164; Vines' "Text-book," 202; Westermaier's "General botany," 419; Woods Holl "Biological lectures," 249; Zimmermann's "Microscopical methods" (Humphrey transl.), 43.
Rhamphospora Nymphaeæ, 188.
Rhinotrichum, macrosporum, 245; tenellum, 245.
Rhipidium interruptum, 49.
Rhizobia, 28.
Rhizophidium globosum, swarm spores of, 503.
Rhizophora, conjugata, 328; Mangle, 327; mucronata, 328.
Rhizopogon rubescens, 37.
Rhus glabra and insects, 111.
Riccia, 273; **aggregata**, 275; albida, 274; arvensis, 274; **Brandegei**, 275; californica, 274; Catalinæ, 275; ciliata, 277; crystallina, 273, 275; Donnellii, 277; Frostii, 273, var. **major**, 273; glauca, 277; hirta, 274; Huebeneriana, 276; lamellosa, 274; Lescuriana, 277; lutescens, 276; minima, 277; nigrella, 277; tenuis, 276; tumida, 277; *Watsoni*, 273.
Rice, wild, 504.
Richardia africana, 241.
Roots, geotropic sensitiveness, 475; penetrating living tissues, 475.
Rosa Nutkana, var. **hispida**, 335.
Rose, a curious, 37.

S

Saccharomyces, 168.
Sagittaria, 342.
Salix, some large plants, 424.
Salsola Kali, 82, 300, 415, 506.
Salvia **Shannoni**, 256.
Sapromyces, *dubius*, 54; Reinschii, 54.
Saprophytes, preserving, 45.
Saraca cauliflora, 501.
Sarratia Berlandieri, 268.
Schizosaccharomyces octosporus, 345.
Scirpus lacustris, 506.
Scouleria, 378.
Scutellaria **Footeana**, 118.
Secondary schools, botany in, 211.
Seeds, color bodies in, 407; germination in sawdust, 333; number in relation to various phenomena, 45.
Seminar, botanical of Washington, 169.
Sericocarpus tortifolius, 35.
Sesbania grandiflora, 499.
Sex in plants, 307.
Siam, Leguminosæ of, 498.
Sicyos angulatus, poisonous, 200.
Silene, generic, subdivisions, 84.
Silphium laciniatum, 36.
Slides, ruled, 416, 507.
Smilaceæ, 515.
Smith College, botany at, 474.
Solanum triflorum, 415.
Solidago, and Aster, 211; tortifolia, 35.
Sphaeroplea annulina, 246.
Sphagnum, microspores of, 167.
Stipules, origin of, 515.
Strasburger, a sketch, 401.
Strawberry, origin of cultivated, 212.
Strobilus in archegoniates, 476.
Sugars, quantitative determination of, 45.
Summer schools, Harvard Univ., 209; N. H. Coll. of Agric., 212; Stanford Univ., 213; Woods Holl, 254.
Swarm spores of Rhizophidium, 503.
Symbiosis of algæ and bacteria with Cycas, 25.
Synchytrium on Stellaria, 296.
Systematic Botany of N. Am., 201.

T

Taphrina, aurea, 380; Johansonii, 380; parasitic on Populus, 380; rhizophora, 380.
Teratology, Hepatica triloba, 338; peculiar ovary, 298; Trillium cernuum, 337.
Terebinthaceæ, structure of, 427.
Tetraplodon mnioides, 200.
Thamnium **Holzingeri**, 239.
Tilletia **Elymi**, 305.
Timmia austriaca, var. **brevifolia**, 238.
Tolyposporium bullatum, 189; **Davidsonii**, 305.
Torreya, as a generic name, 379.
Torsion of leaves, 251.
Trees, growth of, 379; large, 378; meaning of life of, 422.
Trichia, erecta, 91; fallax, 89.
Trichilia, **colimana**, 40; **Donnell-Smithii**, 2; **Heydeana**, 3; **Palmeri**, 39.
Trichomanes, filicula, 395; pyxidiferum, 394; radicans, 395.
Trifolium, pratense, 293; repens, 293, rhizobia of, 28.
Trillium, cernuum, 337; sessile, 460.
Triplaris **Macombii**, 257.
Tubercles of Leguminosæ, 290.

U

Ulmus, 462.
Umbelliferæ, a new genus, 466, 515.
Uredineæ, 303; formation of sporidiola, 81.
Uromyces **minimus**, 415.
Ustilagineæ, 185, 303; systematic position of, 128.
Ustilago sphaerogena, 189.
Utricularia vulgaris, animal food of, 254.
Uvaria crinita, 500.

V

Vacuole, special membrane of, 46.
Variability, relation of age to, 380.
Verbascum nigrum, 415.
Vicia sativa, 292.
Viscum album, haustoria of, 46.
Vivipary in mangroves, 327.
Volvocineæ, a new genus, 279.

W

Walnuts, hybrid, 513.
Ware collection of models, 144.
Willows, flora of pollard, 84.
Wood, of Coniferæ, 514; insect attacks, 380; pine and oak, 409.
Woodsia mollis, 395.
Woodwardia virginica, 200.

X

Xanthoxylum americanum and insects, 109.
Xylia, 502.

Y

Yeast, cultures of, 424; a new, 345.

Z

Zizania aquatica, 504.

INDEX TO AUTHORS

Atkinson, Geo. F., 40, 129, 244, 467, 503.

Bay, J. Christian, 68, 168, 211, 213, 251, 253, 254, 301, 302, 321, 406, 473, 474.
Beal, W. J., 416, 468, 507.
Bergen, Fannie D., 429.
Blodgett, Frederick H., 61.
Bray, Wm. L. (& Uline), 268, 313.

Cardot, J. (& Renauld), 237.
Carleton, M. A., 81.
Cheney, L. S., 384, 409.
Clendenin, Ida, 296.
Clinton, G. P., 383, 415.
Coues, Elliott, 504.
Coulter, John M. (& Rose), 466.
Coville, F. V., 121, 208, 504.
Culbertson, Glenn, 499.

Davenport, Geo. E., 389, 493.
Davis, Bradley M., 96.
Davis, J. J., 415.
Deane, Walter, 144, 225, 338, 507.
De Candolle, Casimir, 39.
Dietel, P., 302.
Durand, Elias J., 89.

Fernald, Merritt L., 335.
Foerste, August F., 33, 460.

Ganong, W. F., 136.
Golden, Katherine E., 113.
Grout, A. J., 200.

Halsted, Byron D., 290.
Harper, R. A., 46.
Harshberger, John W., 159, 307.
Heald, F. D., 293, 477.
Hicks, G. H., 327, 407.
Hill, E. J., 171, 507.
Hitchcock, A. S., 42.
Holm, Theo., 66, 67, 413.
Humphrey, James Ellis, 401.

ohnson, L. N., 56.

Kennedy, George G., 468.
Koehne, E., 350.
Kuntze, Otto, 126.

MacDougal, D. T., 47, 71, 120, 332.
MacMillan, Conway, 19, 246, 252.
Meehan, Thomas, 158.
Mottier, D. M., 383.
Mulford, A. Isabel, 117.
McClatchie, A. J., 245.

Newcombe, Frederick C., 149, 191, 229.

Olive, Edgar W., 178.
Owen, Maria L., 337.

Pillsbury, J. H., 15.
Pound, Roscoe, 422.

Redfield, John H., 387.
Reed, Minnie, 298, 336.
Renauld, F. (& J. Cardot), 237.
Rex, Geo. A., 397.
Robertson, Charles, 103.
Rose, J. N. (& Coulter), 466.
Russell, H. L., 284.

Schaffner, John H., 445.
Schneider, Albert, 25.
Setchell, William Albert, 185.
Shaw, Walter R., 279.
Smith, John Donnell, 1, 255.
Stone, G. E., 333.

Thaxter, Roland, 49.
Tilden, Josephine E., 334.

Uline, Edwin B. (& Bray), 268, 313.
Underwood, L. M., 273, 347.

Walker, Ernest, 241.
White, David, 71.
Wright, S. G., 215.